GUIDELINE

for implementing international CT chains in the BSR

Output 2.2

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List of Abbreviations

BSR	Baltic Sea Region
CT	Combined Transport
GIS	Geographical Information System
GVA	Gross Value Added
KPI	Key Performance Indicators
kt	kilo tons
LLA	Latvian Logistics Association
LU	Loading Unit
MoT MT	Mode of Transport Ministry of Transportation
O-D	Origin-Destination
RoRo	Roll-on-Roll-off
SDG	Sustainable Development Goals
TEN-T	Trans-European Transport Network
UIC	International union of railways
UNECE	United Nations Economic Commission for Europe

1 INTRODUCTION

As outlined in Output 2.1 of the COMBINE project, transport in the Baltic Sea Region (BSR) is predominantly organized on road, which becomes apparent when analyzing the shares of the different transport modes compared to the overall cargo volumes being transported within the BSR and to its neighboring countries. Apart from ports located in cities along the coastline of the Baltic Sea, the region is to a large extent rurally coined, hinterland traffic mainly organized in trucks and semi-trailers, and the last mile of transport chains is longer than in other European regions.

In order to compete with well-established (road) transport chains, Combined Transport (CT) in the BSR must generate efficiency gains in its transport chain and its organization, respectively. Generally, the efficiency of CT increases with long main legs and short last miles, while additional costs connected to changes of transport modes, i.e. the transshipment of cargo from road to rail and/or maritime as well as inland waterways must be compensated.

Identifying trade lanes in the BSR in which CT chains can be integrated is the first step towards strengthening CT in BSR. In addition, there is a need for knowledge about measures and fields of application where and how the identified potentials can be exploited. This is addressed in this guideline.

2 METHODOLOGY: MOST PROMISING TRADE LANES TOUCHING BSR COUNTRIES FOR THE IMPLEMENTATION OF CT CHAINS AND THEIR ESTIMATED POSSIBLE CT VOLUMES

The aim is to identify most promising international trade lanes touching BSR countries for the implementation of CT chains. We approach this question on two levels.

On the first level we evaluate public available traffic data (EUROSTAT, UIC, UIRR) and derive both the selection of promising trade lanes for the implementation of CT and the estimation of CT volumes transported on them. This procedure is based on the assumption that it is an efficient way to shift traffic from road to rail or waterway where those modes of transports already exists and relevant infrastructure is already in place.

On the second level we consult the project partners on their assessment of most promising trade lanes. This ensures that promising trade lanes are also mapped, which do not necessarily appear in the data analysis from level I.

In conclusion, the methodology outlined attempts to define promising trade lanes and, in a subsequent step, estimate the potential for modal shift in the BSR by analyzing on publically available EUROSTAT and UIRR data sources as well as information provided by industry stakeholders, logistics associations, traffic authorities and the like represented in the COMBINE project.

2.1 Most promising trade lanes touching BSR Countries for the implementation of CT chains and their estimated possible CT volumes based on EUROSTAT, UIRR and UIC Data

We define most promising trade lanes for implementing CT chains as trade lanes with a preferably high potential of shifting cargo volumes from road to rail and waterways.

We assume that there is a high shifting potential where, on the one hand, a comparatively high volume of cargo is transported on the trade lane and, at the same time, the existing CT share is as high as possible.

Therefore, we are looking for trade lanes in the study area, with a high total cargo volume and a high CT Volume at the same time.

The study area consists of Denmark, Sweden, Finland, Estonia, Latvia, Lithuania and Poland.

2.1.1 Trade Lane Selection based on Data analysis

To define promising trade lanes for implementing CT chains touching BSR countries we proceed as follows. To ensure a strong link to the study area, we focus on trade lanes whose origin and destination lies within the BSR. The study area consists of Denmark, Sweden, Finland, Estonia, Latvia, Lithuania and Poland. Other countries are also included as destinations if there is a significant rail cargo volume on the respective trade lane. Based on the data available, we consider trade lanes at country level. We refer to the export values. Our aim is to include promising trade lanes from the entire study area in the study. We therefore exclude Germany from the analysis as an origin of a trade lane because of its, for the area under study, unrepresentative high export volume. In order to avoid further agglomerations on relations between only a few strong export countries, we refer to the respective top O-D relations at country level instead of the BSR as a frame of reference.

The first step is an initial assessment of the most important trade lanes of the countries represented in the COMBINE project undertaken by referring to the project's cargo flow visualization tool (Combine Project, 2019). Based on EUROSTAT data (2007 – 2018), the tool provides a list of the Top O-D relations in terms of volumes (kt) for the BSR countries represented in the COMBINE project. As we are looking for the most promising trade lanes, we define the Top 10 O-D relations of a country as the quantity under investigation.

Top O-D-Relations (Cargo Volume in thousand tonnes)

		Mode of transport			
	Total Cargo Volume	inland waterway	maritime waterway	rail	road
Denmark with Germany	45,386	2	19,307	102	25,975
Denmark with Sweden	30,833		21,177	38	9,618
Denmark with Norway	9,731		6,856	3	2,872
Denmark with Italy	5,680		126	5,011	543
Denmark with Netherlands	5,277	17	2,634	3	2,623
Denmark with Poland	5,165		1,139	1	4,025
Denmark with United Kingdom	4,169		3,832		337
Denmark with United States	3,435		3,435		
Denmark with Belgium	3,246	29	2,186	2	1,029
Denmark with France	1,591		65	2	1,524

Table 1: Denmark Top O-D Relations, Export 2018 (Combine Project 2019)

Table 1 shows the Top 10 TOP O-D relations from Denmark. Those of the Top O-D relations with a destination within the BSR are selected for further consideration. In addition, relations with a comparatively high rail share are selected for further consideration even if the destination lies outside the BSR. In table 1 the according trade lanes are marked with a green frame. Based on the assumption in 2.1 we are looking for trade lanes with a high overall trade volume and a high CT Volume at the same time.

This is complex, as no data is available for the total CT cargo volume on the trade lanes. Therefore, an approximation has to be done. The cargo flow tool based on EUROSTAT Data shows the total cargo volume of a trade lane as the sum of the Modes of Transport (MoT) inland waterway, maritime waterway, rail and road.

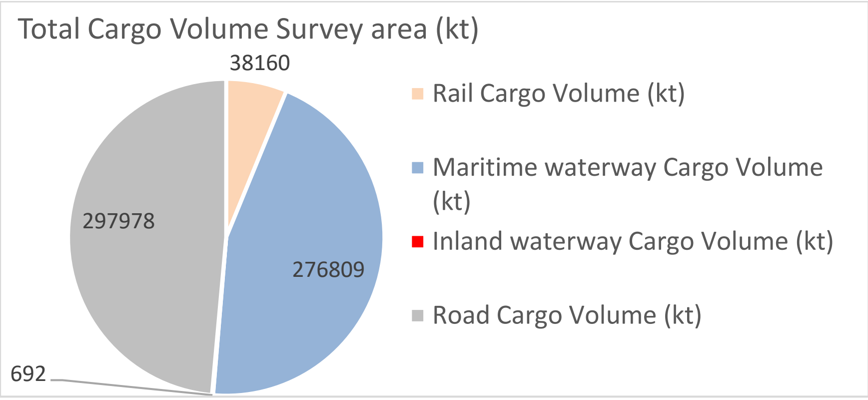


Figure 1: Mode of Transport Volumes in the survey area (SGKV, own illustration according to Combine Project 2019)

Figure 1 displays the shares of the MoTs in the Total Cargo Volume of the study area for 2018. From the 2020 Report on Combined Transport in Europe (UIC, 2020) we know whether the importance of the main leg on waterway in the Baltic Sea region, 74% of the transport chains start in a port and are of maritime character. If we now look at the distribution of the MoTs in Figure 1, it is striking that the volume transported on the MoT rail is relatively low. As CT by rail only represents a share of the MoT rail, it can be assumed that the volume of CT transported by rail is correspondingly lower. Against this background, our preliminary estimate of CT volumes on the identified trade lanes focuses on the maritime sector. As the MoT rail is still important, e.g. for future CV volumes, we check whether it is available. If there is no information about the rail volume in the Cargo Flow Visualization Tool based on EUROSTAT data, we check the presence of rail transports with the Cargo Flow Visualization Tool based on UIRR/UIC (Combine Project, 2020). When looking at the volume shares in Figure 1, it is noticeable that the MoT inland waterway on the trade lanes in the study area plays only a minor role. Therefore, we decided to carry out a preliminary estimate of the CT volumes on the chosen trade lanes based on the MoT maritime waterway.

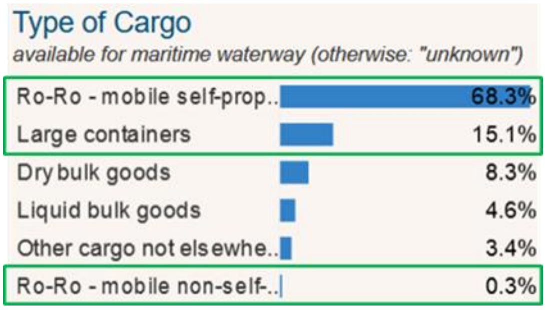


Figure 2: Type of Cargo for Maritime Waterway Denmark-Germany Export 2018 (Combine Projekt 2019)

As there is no explicit data for CT traffic on the MoT maritime waterway, an approximation is necessary.
The Cargo Flow Visualization Tool based on EUROSTAT data provides a differentiation of the types of cargo for the MoT maritime waterway. The types of cargo are large containers, Ro-Ro mobile self-propelled, Ro-Ro mobile non-self-propelled, dry bulk goods, liquid bulk goods and other cargo not elsewhere specified. Figure 2 shows the type of cargo for Danish exports to Germany in 2018. The

types of cargo have a different CT-affinity. Seeing as dry and liquid bulk goods generally show a low CT-affinity, these two types of cargo will not be considered for the definition of promising trade lanes. Furthermore, the type of cargo “other cargo not elsewhere specified” is excluded due to a lack of assessability of its CT affinity. Large containers and the two RoRo variants on the other hand show a rather high CT-affinity and will therefore be focused on.

We define the volumes of the types of Cargo with a high CT-affinity on the MoT maritime waterway as the CT-affine Mode of Transport maritime waterway. For the initial assessment of the CT volume on the selected trade lanes, we therefore refer to an estimate of the CT-affine volume on the MoT maritime waterway. Since we are looking for the most promising trade lanes, we specify a minimum value for the share of CT affine volumes. We therefore determine that a trade lane qualifies for further consideration if the share of its CT affine volume is more than 30%.

The selection of promising trade lanes for the implementation of CT chains is based on the following parameters:

I the top 10 O-D relations of the countries in the study area

II Trade partners within the BSR; trade partners in other European regions are included in the assessment if the volumes transported on rail are high

III existing connections on rail: indication on the potential for a modal shift

IV existing connections on waterway: indication on the potential for a modal shift

V Of the trade lanes identified, those with a CT affine maritime waterway share of more than or equal to 30% are taken into account for further consideration.

If a trade lane qualifies for further examination according to these parameters, the methodology for estimating possible CT volumes is applied.

2.1.2 Estimated possible CT volumes based on Data analysis

For the estimation of possible CT volumes, we map both a historical overview (2013-2018) and a future forecast for the year 2030 for the selected trade lanes.

The historical overview represents the sum of the CT rail volume (UIRR Data) and the CT affine Maritime Waterway and the CT affine Inland Waterway volumes (EUROSTAT Data) in the respective year.

For the CT growth factor in the study area, we combine the three modes of transport and their growth factors and form a common growth factor for the estimation of possible future CT volumes. From the 2020 Report on Combined Transport in Europe an average growth factor for CT rail in Europe of 5,47% per year can be derived (UIC, 2020). In view of the regional characteristics, the relatively high share of water-side CT and the relatively low share of rail-side CT in the BSR and on the trade lanes studied, we adjust the growth factor for the study area. We therefore assume a regional growth factor

for rail CT of 2,74% per year. We calculate the annual growth factor for water-side CT for each of the selected trade lanes from the annual volume changes of the CT affine maritime waterways.
Since we are looking for the "most promising trade lanes", we calculate the average CT growth factor of the selected trade lanes. We assume that a trade lane is promising if its growth factor is higher than the average growth factor of the trade lanes studied.
Since there is no uniform, comparable data basis for CT volumes on trade lanes in the BSR, and thus also not on the trade lanes identified according the methodology in 2.1.1, we must also develop a concept of approximation for an analysis of potential that allows us to estimate comprehensible values for possible CT volumes on the selected trade lanes. For the preliminary estimation of the ratio between CT share and Total Cargo Volume for the identification of promising trade lanes, we have concentrated on the MoT maritime waterway as outlined in 2.1.1. The shares of the other MoTs on the trade lanes in the study area are too small to decide on the relevance of a trade lane in terms of selecting promising trade lanes. Nevertheless, there are volumes on the MoTs rail and inland waterway, at least on some of the identified trade lanes. Despite small volumes, we would like to include them proportionally in the potential analysis. On the one hand, this is done for reasons of completeness, but on the other hand it also serves to ensure that the methodology presented can be adapted accordingly if the data situation improves. This is guaranteed by the fact that all MoT are placed in relation to the corresponding volumes and are included in the analysis.

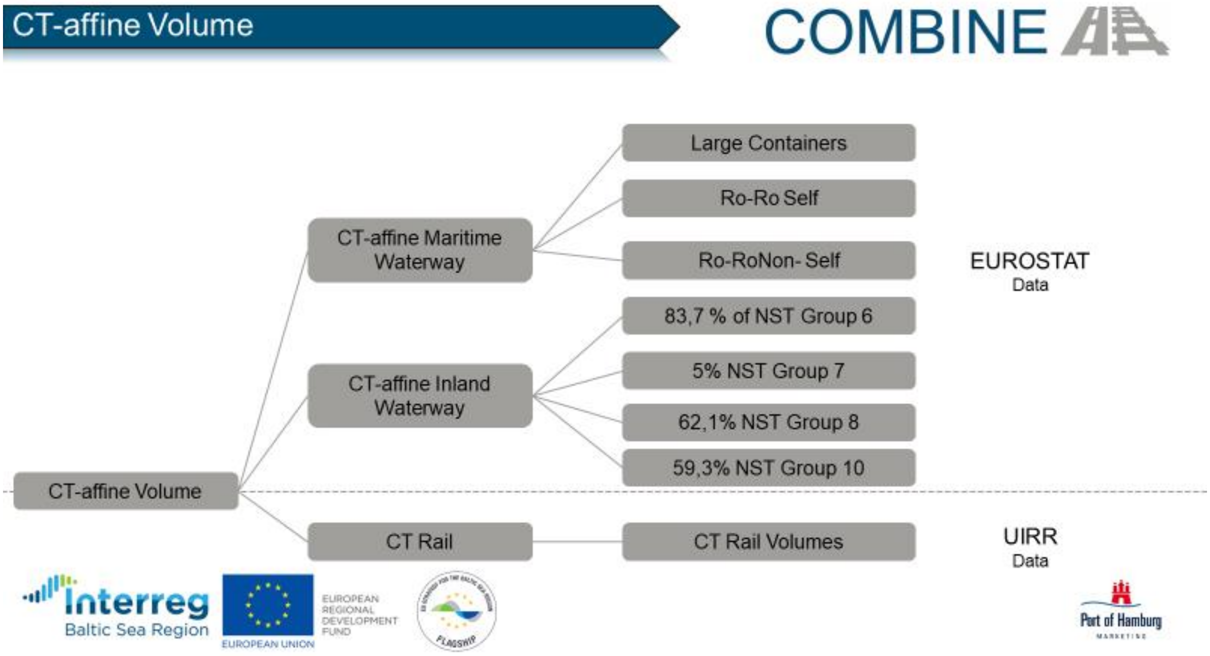


Figure 3: Chart for CT-affine Cargo Volume (SGKV own illustration)

The CT affine volume of a trade lane consists of the CT affine volumes of the MoTs maritime waterway and inland waterway and the CT volume of the MoT rail.
To determine the CT-affine MoT maritime waterway, we proceed as described in 2.1.1.

For the MoT inland waterway we have EUROSTAT data on groups of goods. The four groups of goods 06, 07, 08 and 10 are transported on the identified trade lanes. The values for the CT affinity of the commodity groups are also approximations. They contain data and weighted results of different studies. For freight group 06, the CT affinity share is 83.7% for freight group 10 is 59.3%. As a CT-affine MoT inland waterway on a trade lane, we take the appropriate proportion of the total MoT IW according to the groups of goods transported.

For the MoT rail, the cargo flow analysis tool based on UIRR data contains values for CT volumes on the identified trade lanes.

In order to estimate possible CT volumes for the trade lanes, we provide an overview of the development of CT affine volumes on the trade lanes for the years 2013-2018 and also give a forecast for possible CT affine volumes on the trade lanes in the future.

We calculate the growth factor used for the forecast from the respective growth factors of the individual MoT. We calculate the growth factors of the MoT maritime waterway and inland waterway from the volume changes from 2013-2018. We take the growth factor for the MoT rail from the 2020 Report on Combined Transport in Europe (UIC, 2020) and adjust it according to the BSR. Due to the lower development of the MoT rail in the region, we reduce the growth factor for rail-side CT from the report by 50%.

As we are looking for the most promising trade lanes, we are establishing a minimum value for the growth factor of the CT-related volume above which a trade lane is considered promising. As a minimum value we determine the average value of the growth factors of the identified trade lanes. We define the selected trade lanes with an above-average growth factor as the most promising trade lanes at country level in the BSR.

2.2 Most promising trade lanes touching BSR Countries for the implementation of CT chains and their estimated possible CT volumes based on Partner Input

Apart from utilizing EUROSTAT and UIRR data for the definition of promising trade lanes and estimating possible CT volumes on them, input from the COMBINE project partners has been retrieved in this regard. Based on the Top-O-D relations featured in the visualization tool, a number of promising trade lanes were suggested to the partners. They were then asked to confirm the suggested trade lanes and provide additional ones based on their knowledge and experience.

The advantage of this approach is that important trade lanes, which are due to comparably low volumes not visible as such in the EUROSTAT data, are also included in the guideline. In addition, it safeguards the inclusion of information that is close to practice and potentially more detailed. As the partners were asked to state, if possible, specific terminals situated along the identified trade lanes as well as their respective handling volumes, a higher degree of detail is achieved.

Including the partners' input is additionally important for the potential analysis as it allows an estimation of the trade lanes that will become important for implementing international CT chains in the BSR, whereas the EUROSTAT and UIRR data give an impression of the trade lanes that currently show high cargo volumes.

3 MOST PROMISING TRADE LANES TOUCHING BSR COUNTRIES FOR THE IMPLEMENTATION OF CT CHAINS AND THEIR ESTIMATED POSSIBLE CT VOLUMES

As first step, promising trade lanes are defined on which possible CT potentials are estimated in the second stage.

3.1 Overview of promising Trade Lanes – Country Profiles

The following profiles give an overview of the countries represented in the COMBINE project and their respective most important trade partners.

Seeing as Germany's export statistics considerably exceed those of the other countries represented in the project and therefore might not be representative for the BSR as a whole, it will not be considered in the country profiles. In addition, Belgium will also be excluded, as it has no shoreline along the Baltic Sea.

Even beyond Germany, the total export volumes of the countries in the BSR differ, sometimes significantly. In order to include trade lanes from the entire study area in the study and to avoid an agglomeration of a few, particularly export-strong countries, we put the first criterion of the high total cargo volume of a trade lane in relation to the respective country level.

3.1.1 Sweden

Top O-D-Relations (Cargo Volume in thousand tonnes)

	Total Cargo Volume	Mode of transport: inland waterway	maritime waterway	rail	road
Sweden with Norway	44,508		5,872	20,632	18,004
Sweden with Germany	44,393		31,638	3,321	9,434
Sweden with Denmark	23,521		15,340	360	7,821
Sweden with Finland	21,396		14,692	1	6,703
Sweden with Poland	19,470		10,700	11	8,759
Sweden with United Kingdom	15,117		14,975		142
Sweden with Netherlands	13,188		10,279	200	2,709
Sweden with Belgium	12,327	27	11,579	238	483
Sweden with Spain	3,350		3,019	83	248
Sweden with Latvia	2,991		2,326		665

Table 2: Sweden Top O-D Relations, Export 2018 (Combine Project 2019)

Parameter I-II
With parameter I the following trade lanes can be identified on country level, Sweden-Germany, Sweden-Denmark, Sweden-Finland, Sweden-Poland and Sweden-Latvia are the top trade lanes to other BSR countries. Sweden Norway is included because of the high share of rail.

Parameter III

At first sight rail transport takes place on all identified trade lanes at country level except on trade lane Sweden-Latvia. Of particular note are the trade lanes Sweden-Norway with the highest rail share (46.36% of total cargo volume), and trade lane Sweden-Finland with the lowest rail share among Sweden's top O-D Relations where there is rail traffic. Even when checking the Cargo Flow Visualization Tool based on UIRR/UIC (Combine Project, 2020) for rail-side traffic, there is no rail traffic on the trade lane Sweden-Latvia.

Parameter IV

Sweden-Norway

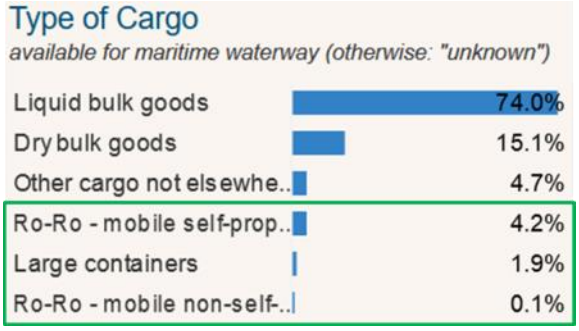


Figure 4: Type of Cargo for Maritime Waterway Sweden-Norway Export 2018 (Combine Project 2019)

The CT affine type of cargo at the maritime waterway for the trade lane Sweden-Norway accounts for 6.2% of the total volume of the per mode of transport maritime waterway transported goods. All three types of cargo defined as CT affine are available, but it should be emphasized that the share of all three is comparatively low.

Sweden-Germany

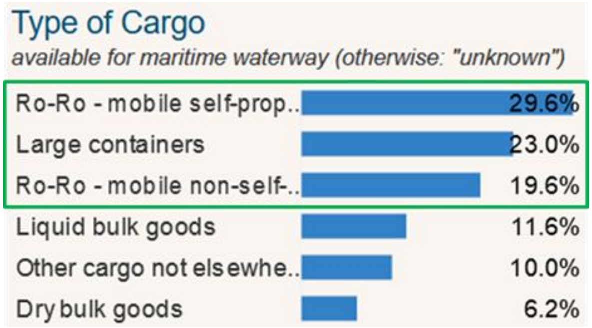


Figure 5: Type of Cargo for Maritime Waterway Sweden-Germany Export 2018 (Combine Project 2019)

The CT affine type of cargo at the maritime waterway for the trade lane Sweden-Germany accounts for 72.2% of the total volume of the mode of transport maritime waterway transported goods. All three types of cargo defined as CT affine are available. It should be emphasized that the share of the three CT-affine types of cargo is comparatively high.

Sweden-Denmark

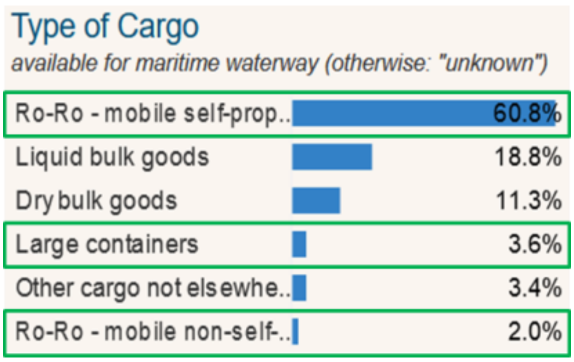


Figure 6: Type of Cargo for Maritime Waterway Sweden-Denmark Export 2018 (Combine Project 2019)

The CT affine type of cargo at the maritime waterway for the trade lane Sweden-Denmark accounts for 66.4% of the total volume of the mode of transport maritime waterway transported goods. All three types of cargo defined as CT affine are available. It is noticeable that the share of type of cargo Large container and Ro-Ro-mobile non-self-propelled is relatively low compared to the share Ro-Ro-mobile self-propelled.

Sweden-Finland

Figure 7: Type of Cargo for Maritime Waterway Sweden-Finland Export 2018 (Combine Project 2019)

The CT affine type of cargo at the maritime waterway for the trade lane Sweden-Finland accounts for 28.5% of the total volume of the per mode of transport maritime waterway transported goods. All three types of cargo defined as CT affine are available. It is noticeable that the share of type of cargo Large container and Ro-Ro-mobile non-self-propelled is relatively low.

Sweden-Poland

Figure 8: Type of Cargo for Maritime Waterway Sweden-Poland Export 2018 (Combine Project 2019)

The CT affine types of cargo at the maritime waterway for the trade lane Sweden-Poland accounts for 89.2% of the total volume of the per mode of transport maritime waterway transported goods. All three types of cargo defined as CT affine are available. Again, the share of Ro-Ro-mobile non-self-propelled and Large containers is relatively low.

Sweden-Latvia

Figure 9: Type of Cargo for Maritime Waterway Sweden-Latvia Export 2018 (Combine Project 2019)

The CT affine types of cargo at the maritime waterway for the trade lane Sweden-Poland accounts for 73.4% of the total volume of the mode of transport maritime waterway transported goods. All three types of cargo defined as CT affine are available.

3.1.2 Denmark

Top O-D-Relations (Cargo Volume in thousand tonnes)

	Total Cargo Volume	Mode of transport: inland waterway	maritime waterway	rail	road
Denmark with Germany	45,386	2	19,307	102	25,975
Denmark with Sweden	30,833		21,177	38	9,618
Denmark with Norway	9,731		6,856	3	2,872
Denmark with Italy	5,680		126	5,011	543
Denmark with Netherlands	5,277	17	2,634	3	2,623
Denmark with Poland	5,165		1,139	1	4,025
Denmark with United Kingdom	4,169		3,832		337
Denmark with United States	3,435		3,435		
Denmark with Belgium	3,246	29	2,186	2	1,029
Denmark with France	1,591		65	2	1,524

Table 3: Denmark Top O-D Relations, Export 2018 (Combine Project 2019)

Parameter I-II

With Parameter I the trade lanes Denmark-Germany, Denmark-Sweden and Denmark-Poland can be identified. Due to the comparatively high share of rail, Trade-Lane Denmark-Italy also qualifies for further consideration.

Parameter III

All of the identified trade lanes have rail traffic.

Parameter IV

The MoT inland waterway is existing on the trade lane Denmark-Germany.

Denmark-Germany

On the Trade Lane Denmark-Germany all three types of cargo defined as CT affine occur. Together they have an 83.7% share of the Mode of transport maritime waterway. The comparatively low share of ro-ro-mobile non-self-propelled (0.3%) is striking, while ro-ro-mobile self-propelled is the type of cargo with the largest share of the mode of transport maritime waterway.

Figure 10:Type of Cargo for Maritime Waterway Denmark-Germany Export 2018 (Combine Project 2019)

Denmark-Sweden

At trade lane Denmark-Sweden all three types of cargo defined as CT affine occur. Together they have a share of 52.5%.

Figure 11: Type of Cargo for Maritime Waterway Denmark-Sweden Export 2018 (Combine Project 2019)

Denmark-Poland

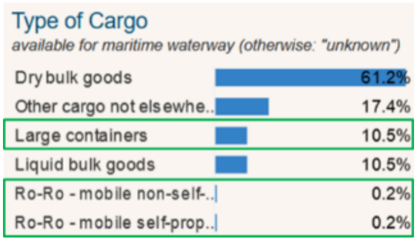
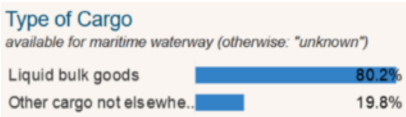


Figure 12: Type of Cargo for Maritime Waterway Denmark-Poland Export 2018 (Combine Project 2019)

On Trade lane Denmark-Poland all three types of cargo defined as CT affine occur. Together they have a 10.9% share of the mode of transport maritime waterway. The comparatively low overall share of the three types of cargo and the low share of the two ro-ro variants is striking. Together they account for only 0.4% of the mode of transport maritime waterway on the trade lane Denmark-Poland.

Denmark-Italy



On trade lane Denmark-Italy there is no transport of the type of cargo defined as CT affine.

Figure 13: Type of Cargo for Maritime Waterway Denmark-Italy Export 2018 (Combine Project 2019)

3.1.3 Finland

Top O-D-Relations (Cargo Volume in thousand tonnes)

	Total Cargo Volume	Mode of transport: inland waterway	maritime waterway	rail	road
Finland with Germany	21,659	14	21,493		152
Finland with Sweden	20,527		13,048	12	7,467
Finland with Belgium	9,815	15	9,771		29
Finland with Estonia	8,527		7,179	0	1,348
Finland with Poland	3,944		3,540		404
Finland with Latvia	2,210		1,618		592
Finland with Norway	2,181		1,104	0	1,077
Finland with Lithuania	1,551		915		636
Finland with Denmark	1,355		1,186		169
Finland with Czech Republic	436				436

Table 4: Finland Top O-D Relations, Export 2018 (Combine Project 2019)

Parameter I-II

With parameter I the following trade lanes can be identified on country level, Finland-Germany, Finland-Sweden, Finland-Estonia, Finland-Poland, Finland-Latvia, Finland-Lithuania, Finland-Denmark.

Parameter III

Based on the Eurostat data, rail traffic can only be identified on trade lane Finland-Sweden. On this trade lane, the small share of rail transport should be emphasized. Looking at the UIC data, rail traffic on the trade lanes Finland-Germany and Finland Poland can be affirmed.

Parameter IV

Inland Waterway is existing on the trade lane Finland-Germany.

Finland-Germany

Figure 14: Type of Cargo for Maritime Waterway Finland-Germany Export 2018 (Combine Project 2019)

With regard to the CT affine maritime waterway, the relatively high share of 73.9% of the total type of cargo maritime waterway is striking. This is also remarkable as it is the top O-D relation in Finland with the highest total cargo volume. Within the type of cargo defined as having an affinity to CT, large containers account for the largest share.

Finland-Sweden

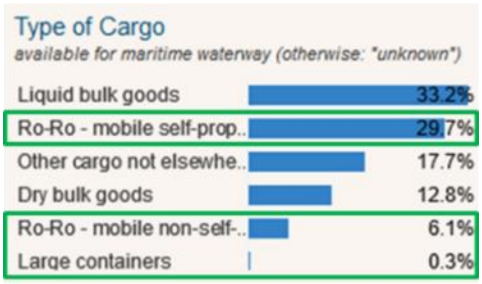


Figure 15: Type of Cargo for Maritime Waterway Finland-Sweden Export 2018 (Combine Project 2019)

In contrast to trade lane Finland-Germany, the type of cargo large containers is by far the one with the lowest share (0.3%). The total share of the types of cargo defined as having an affinity for CT in the mode of transport Maritime waterway is also lower at 36.1%. The comparison is particularly interesting because the total cargo volumes of the two trade lanes are close together.

Finland-Estonia

Figure 16: Type of Cargo for Maritime Waterway Finland-Estonia Export 2018 (Combine Project 2019)

At trade lane Finland-Estonia, all three of the types of cargo defined as CT affine can be found. Together they have a 72.5% share of the mode of transport maritime waterway.

Finland-Poland

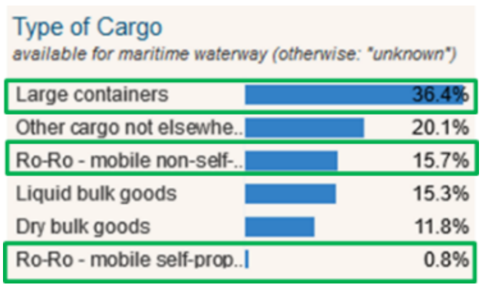


Figure 17: Type of Cargo for Maritime Waterway Finland-Poland Export 2018 (Combine Project 2019)

At trade lane Finland-Poland, the three types of cargo defined as CT affine have a combined share of 52.9%. It is remarkable that Ro-Ro-mobile self-propelled has a share of only 0.8.

Finland-Latvia

Figure 18: Type of Cargo for Maritime Waterway Finland-Latvia Export 2018 (Combine Project 2019)

On the trade lane Finland-Latvia, only large containers are used as a CT affine type of cargo. The proportion is 27.2%.

Finland-Lithuania

Figure 19: Type of Cargo for Maritime Waterway Finland-Lithuania Export 2018 (Combine Project 2019)

Also, on the trade lane Finland-Lithuania only large containers are used as CT affine type of cargo. The proportion is 22.0%.

Finland-Denmark

Figure 20: Type of Cargo for Maritime Waterway Finland-Denmark Export 2018 (Combine Project 2019)

At trade lane Finland-Denmark, the CT affine types of cargo of the mode of transport maritime waterway includes Ro-Ro-mobile non-self-propelled and large containers. The total share of the mode of transport maritime waterway is 26.9%, of which 25.8% is ro-ro-mobile non-self-propelled and only 1.1% is large containers.

3.1.4 Estonia

Top O-D-Relations (Cargo Volume in thousand tonnes)

	Total Cargo Volume	Mode of transport			
		inland waterway	maritime waterway	rail	road
Estonia with Finland	10,006		8,331		1,675
Estonia with Sweden	5,806		5,680		126
Estonia with Latvia	5,423		932	201	4,290
Estonia with United States	4,979		4,979		
Estonia with Netherlands	3,896		3,726		170
Estonia with Germany	3,436		2,940		496
Estonia with Belgium	2,681	82	2,599		
Estonia with Denmark	2,498		2,498		
Estonia with Brazil	2,052		2,052		
Estonia with United Kingdom	1,658		1,658		

Table 5: Finland Top O-D Relations, Export 2018 (Combine Project 2019)

Parameter I-II

The trade lanes identified with parameter I with Estonia as origin are Estonia-Finland, Estonia-Sweden, Estonia-Latvia, Estonia-Germany and Estonia-Denmark.

Parameter III

Rail transport can only be identified on the trade lane Estonia-Latvia data. Also, the check based on UIRR and UIC data does not show any further traffic on rail.

Parameter IV

Estonia-Finland

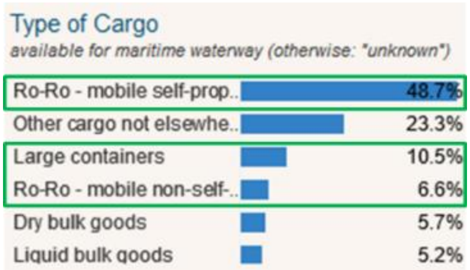


Figure 21: Type of Cargo for Maritime Waterway Estonia-Finland Export 2018 (Combine Project 2019)

The trade lane Estonia-Finland carries all three types of cargo defined as CT affine. The share of the mode of transport maritime waterway is 65.8%.

Estonia-Sweden

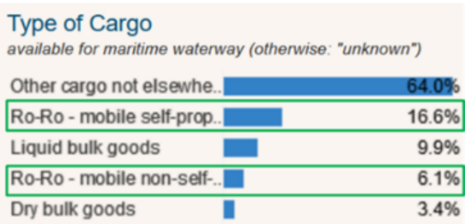


Figure 22: Type of Cargo for Maritime Waterway Estonia-Sweden Export 2018 (Combine Project 2019)

According to Eurostat data, no large containers are transported on this trade lane. Ro-Ro mobile self-propelled and Ro-Ro mobile non-self-propelled together account for 22.7% of the mode of transport maritime waterway.

Estonia-Latvia

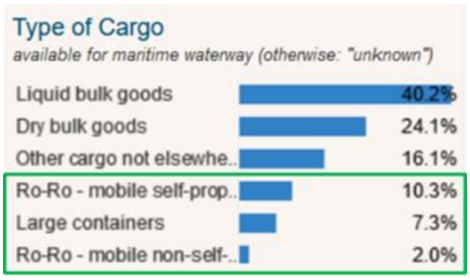


Figure 23: Type of Cargo for Maritime Waterway Estonia-Latvia Export 2018 (Combine Project 2019)

On the trade lane Estonia-Latvia, all three types of cargo defined as CT-affine are present. The comparatively low share of these (19.6%) in the mode of transport maritime waterway is striking.

Estonia-Germany

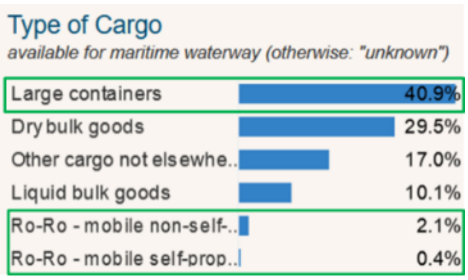
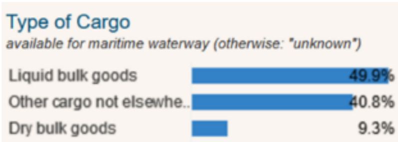


Figure 24: Type of Cargo for Maritime Waterway Estonia-Germany Export 2018 (Combine Project 2019)

Also, on the trade lane Estonia-Germany, all three of the types of cargo defined as CT affine occur. Together they have a 43.4% share of the mode of transport maritime waterway. It is striking that the two Ro-Ro variants together account for only 2.5%, while the largest share is accounted for by large containers.

Estonia-Denmark



On trade lane Estonia-Denmark there is no Eurostat data on the three types of cargo defined as CT affine.

Figure 25: Type of Cargo for Maritime Waterway Estonia-Denmark Export 2018 (Combine Project 2019)

3.1.5 Latvia

Top O-D-Relations (Cargo Volume in thousand tonnes)

	Total Cargo Volume	Mode of transport: inland waterway	maritime waterway	rail	road
Latvia with Sweden	14,438		14,256		182
Latvia with Netherlands	13,610		13,457		153
Latvia with Germany	12,130	1	11,564		565
Latvia with Lithuania	11,306		2,169	69	9,068
Latvia with United Kingdom	7,445		7,397		48
Latvia with Denmark	7,329		7,182		147
Latvia with Estonia	6,911		2,108	127	4,676
Latvia with Italy	5,857		5,075		782
Latvia with Belgium	4,980	44	4,819		117
Latvia with Poland	3,910		3,073	7	830

Table 6: Latvia Top O-D Relations, Export 2018 (Combine Project 2019)

Parameter I-II

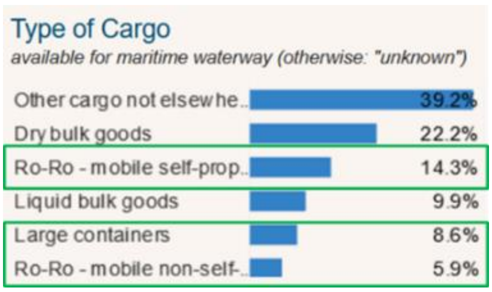
With parameter I the trade lanes Latvia-Sweden, Latvia-Germany, Latvia-Lithuania, Latvia-Denmark, Latvia-Estonia and Latvia Poland can be identified.

Parameter III

Considering the Eurostat data, rail transport can be affirmed for the trade lanes Latvia-Lithuania, Latvia-Estonia and Latvia-Poland. Looking at the UIC and UIRR data, no new rail transports can be identified.

Parameter IV

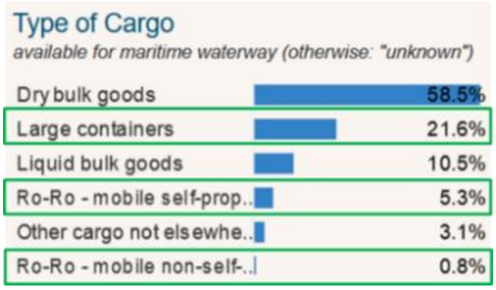
Latvia-Sweden



The trade lane Latvia-Sweden transports all three of the type of cargo defined as CT affine, together they have a 28.8% share of the mode of transport maritime waterway.

Figure 26: Type of Cargo for Maritime Waterway Latvia-Sweden Export 2018 (Combine Project 2019)

Latvia-Germany



On trade lane Latvia-Germany all three of the types of cargo defined as CT affine are transported, together they have a share of 27.7% in the mode of transport maritime waterway.

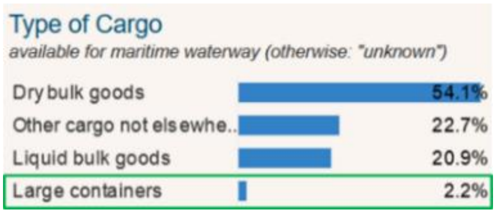
Figure 27: Type of Cargo for Maritime Waterway Latvia-Germany Export 2018 (Combine Project 2019)

Latvia-Lithuania

On the trade lane Latvia-Lithuania only large containers of the type of cargo defined as CT affine are transported. They have a share of 20.2% of the mode of transport maritime waterway.

Figure 28: Type of Cargo for Maritime Waterway Latvia-Lithuania Export 2018 (Combine Project 2019)

Latvia-Denmark



On the trade lane Latvia-Denmark only large containers of the type of cargo defined as CT affine are transported. This has a comparatively small share of 2.2% of the total volume of the mode of transport maritime waterway.

Figure 29: Type of Cargo for Maritime Waterway Latvia-Denmark Export 2018 (Combine Project 2019)

Latvia-Estonia

On the trade lane Latvia-Estonia only large containers of the type of cargo defined as CT affine are transported. This has a share of 16.8%.

Figure 30: Type of Cargo for Maritime Waterway Latvia-Estonia Export 2018 (Combine Project 2019)

Latvia-Poland

On the trade lane Latvia-Poland only large containers of the type of cargo defined as CT affine are transported. This has a share of 40.1%.

Figure 31: Type of Cargo for Maritime Waterway Latvia-Poland Export 2018 (Combine Project 2019)

3.1.6 Lithuania

Top O-D-Relations (Cargo Volume in thousand tonnes)

	Total Cargo Volume	inland waterway	maritime waterway	rail	road
		Mode of transport			
Lithuania with Poland	13,789		4,172	582	9,035
Lithuania with Latvia	13,538		1,212	949	11,377
Lithuania with Germany	9,609	25	6,506	10	3,068
Lithuania with Netherlands	6,856		6,104		752
Lithuania with United States	5,280		5,280		
Lithuania with Sweden	5,184		4,930		254
Lithuania with Estonia	4,025		2,698	762	565
Lithuania with Brazil	3,940		3,940		
Lithuania with Belgium	3,747		3,323		424
Lithuania with United Kingdom	2,989		2,533		456

Table 7: Lithuania Top O-D Relations, Export 2018 (Combine Project 2019)

Parameter I-II

With Parameter I we can identify the trade lanes Lithuania-Poland, Lithuania-Latvia, Lithuania-Germany, Lithuania-Sweden and Lithuania-Estonia.

Parameter III

Considering the Eurostat data, rail transport for trade lanes Lithuania-Poland, Lithuania-Latvia, Lithuania-Germany and Lithuania-Estonia Poland can be affirmed. But there is no rail transport on the trade lane Lithuania-Sweden. Looking at the UIC and UIRR data, no new rail traffic can be identified for the trade lane Lithuania-Sweden.

Parameter IV

Inland Waterway is existing on the trade lane Lithuania-Germany.

Lithuania-Poland

Figure 32: Type of Cargo for Maritime Waterway Lithuania-Poland Export 2018 (Combine Project 2019)

On the trade lane Lithuania-Poland only large containers of the type of cargo defined as CT affine are used. The share of large containers in the total volume of the mode of transport maritime waterway is 41.2%.

Lithuania-Latvia

Figure 33: Type of Cargo for Maritime Waterway Lithuania-Latvia Export 2018 (Combine Project 2019)

On the trade lane Lithuania-Latvia only large containers of the type of cargo defined as CT affine are used. The share of large containers in the total volume of the mode of transport maritime waterway is 34.8%.

Lithuania-Germany

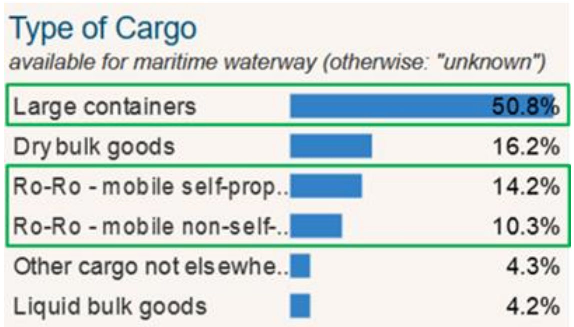


Figure 34: Type of Cargo for Maritime Waterway Lithuania-Germany Export 2018 (Combine Project 2019)

On the trade lane Lithuania-Germany all three of the type of cargo defined as CT affine occur. Together they account for 75.3% of the total volume of the mode of transport maritime waterway.

Lithuania-Sweden

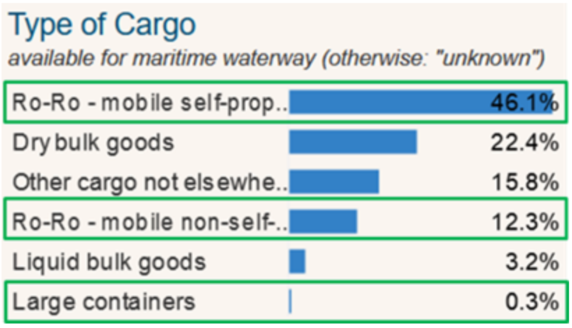


Figure 35: Type of Cargo for Maritime Waterway Lithuania-Sweden Export 2018 (Combine Project 2019)

On the trade lane Lithuania-Sweden, all three types of cargo defined as CT affine occur. Together they account for 58.7% of the mode of transport maritime waterway. It should be emphasized that the type of cargo large containers has a comparatively small share of 0.3%.

Lithuania-Estonia

Figure 36: Type of Cargo for Maritime Waterway Lithuania-Estonia Export 2018 (Combine Project 2019)

On the trade lane Lithuania-Estonia the only one of the types of cargo defined as CT affine with a relevant share is large containers with 14.6%. Ro-Ro mobile self-propelled occur only with very small portion (0.1%) and Ro-Ro-mobile non-self-propelled is listed with 0.0%. The combined share of the type of cargo defined as a CT affine in the total volume of the mode of transport maritime waterway is 14.7% and is therefore comparatively low.

3.1.7 Poland

Top O-D-Relations (Cargo Volume in thousand tonnes)

	Mode of transport				
	Total Cargo Volume	inland waterway	maritime waterway	rail	road
Poland with Germany	141,959	651	9,571	5,753	125,984
Poland with Czech Republic	38,250	1		5,776	32,473
Poland with Sweden	22,119		12,946	103	9,070
Poland with Netherlands	21,914	4	6,717	562	14,631
Poland with Slovakia	21,219			2,697	18,522
Poland with Italy	17,463		1,214	314	15,935
Poland with Lithuania	17,107		2,745	108	14,254
Poland with United Kingdom	16,311		3,723	0	12,588
Poland with France	15,786		962	182	14,642
Poland with Belgium	13,848	5	3,584	95	10,164

Table 8: Poland Top O-D Relations, Export 2018 (Combine Project 2019)

Parameter I-II

With parameter I the trade lanes Poland-Germany, Poland-Sweden and Poland-Lithuania can be identified first. Here the destinations are within the BSR region. Furthermore, the trade lanes Poland-Czech Republic and Poland-Slovakia qualify for a possible further consideration due to the comparatively high share of rail transports

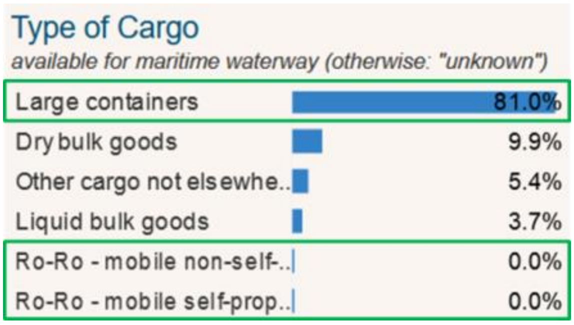
Parameter III

Parameter II can be used to identify rail traffic on all relevant trade lanes.

Parameter IV

Inland Waterway is existing on the trade lanes Poland-Germany and Poland-Czech Republic.

Poland-Germany



On the trade lane Poland-Germany only large containers of the type of cargo defined as CT affine are found. The relatively high share of 81.0% of the total volume of the mode of transport maritime waterway is striking.

Figure 37: Type of Cargo for Maritime Waterway Poland-Germany Export 2018 (Combine Project 2019)

Poland-Sweden

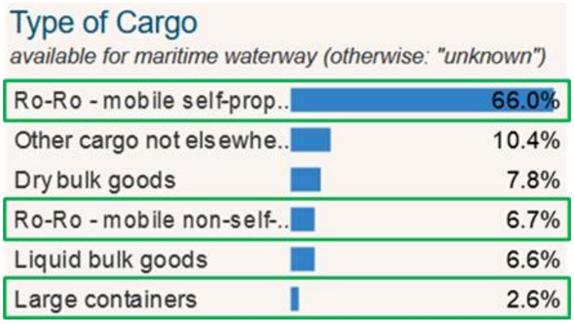


Figure 38: Type of Cargo for Maritime Waterway Poland-Sweden Export 2018 (Combine Project 2019)

On trade lane Poland-Sweden all types of cargo identified as CT affine occur. Together, they account for 75.3% of the total volume of mode of transport maritime waterway. Ro-Ro-mobile self-propelled is with 66% by far the most represented type of cargo, both for the type of cargo identified as having an affinity to CT and in the overall view of all types of cargo on this trade lane.

Poland-Lithuania

Figure 39: Type of Cargo for Maritime Waterway Poland-Lithuania Export 2018 (Combine Project 2019)

The trade lane Poland-Lithuania transports only large containers of the type of cargo defined as CT affine. The comparatively high share of type of cargo large containers (82.6%) in the total volume of the mode of transport maritime waterway is remarkable.

Poland-Czech Republic
No Data for Maritime Waterway

Poland-Slovakia
No Data for Maritime Waterway

3.1.8 Overview Country Profiles Traffic shares

Table 9 shows the results of the country survey that are relevant for the selection of the promising trade lane. The most relevant criterion is the respective CT-affine Mode of Transport maritime waterway. Furthermore, the presence of the MoTs inland waterway and rail is recorded. The information is shown for each trade lane. The trade lanes that qualify for further analysis, and thus the estimation of possible CT potentials, are highlighted in green in the table.

Origin	Destination	CT-affine maritime waterway *Eurostat*	inland waterway transport existing *Eurostat*	rail transport existing *Eurostat/ UIC/UIRR*
Finland	**Germany**	**73,3%**	✔	✔
	Sweden	22,9%		✔
	Estonia	**61,0%**		
	Poland	**47,5%**		
	Latvia	19,9%		
	Lithuania	13,0%		
	Denmark	23,5%		
Estonia	**Finland**	**54,8%**		
	Sweden	22,2%		
	Latvia	3,4%		✔
	Germany	**37,1%**		
	Denmark	0,0%		
Latvia	Sweden	28,4%		
	Germany	26,4%		
	Lithuania	3,9%		✔
	Denmark	2,2%		
	Estonia	5,1%		✔
	Poland	**31,5%**		✔
Lithuania	Poland	12,5%		✔
	Latvia	3,1%		✔
	Germany	**51,0%**	✔	✔
	Sweden	**55,8%**		
	Estonia	9,9%		✔
Poland	Germany	5,5%	✔	✔
	Sweden	**44,1%**		✔
	Lithuania	13,3%		
Sweden	Norway	0,8%		✔
	Germany	**51,5%**		✔
	Denmark	**43,3%**		✔
	Finland	19,6%		✔
	Poland	**49,0%**		✔
	Latvia	**57,1%**		
Denmark	**Germany**	**35,6%**	✔	✔
	Sweden	**36,1%**		✔
	Italy	0,0%		✔
	Poland	2,4%		✔

Table 9: Country Profiles, Selection of most promising trade lanes (SGKV, own illustration)

3.2 Estimated possible CT volumes - Analysis of potential

SGKV

CT 2007-2020 Source: UIC 2018 Report on CT in Europe	
Year	Growth Rate
2013	8,90%
2015	0,96%
2017	7,14%
2018	3,40%
2019	5,40%
2020	5,00%
Average	5,13%

CT 2019-2030 Source: UIC-UIRR 2020	
Expected volume growth of the total CT market	
2019-25	Yearly
31,90%	5,32%
2019-30	Yearly
65,40%	5,95%

Total Average
5,47%

For the trade lanes identified in Chapter XX, we determine the respective growth factor for the CT-affine MoT inland waterway and maritime waterway. For this purpose, we compare the volumes of the two MoT from the years 2013-2018 and determine the average growth factor.

Table 10: CT-Rail Growth Factor (Own illustration according to UIC-ETF 2019, UIC 2020)

We calculate the growth factor for MoT Rail based on data from the 2018 and 2020 UIRR/UIC reports. From the 2018 report, we calculate the average growth factor for the years 2013-2020. Part of these are forecasts. From the 2020 report we take the forecast average growth factors for 2019-30. The average growth factor calculated from this is adjusted for the regional characteristics of the study area and reduced by 50%. The adjusted growth factor for the MoT rail is therefore 2.74%.

Origin	Destination	CT Growth Rate
Finland	Poland	**16,63%**
Estonia	Finland	**7,12%**
	Germany	**7,10%**
Latvia	Poland	**9,55%**
Lithuania	Germany	**7,28%**
	Sweden	**6,67%**
Poland	Sweden	**10,33%**
Sweden	Poland	**8,60%**
Denmark	Germany	**6,76%**

Table 11 CT-affine Growth Rate for selected trade lanes (own illustration)

The next step is to calculate a common weighted growth factor for the KV affine volume of the respective trade lane from the three growth factors of the three KV affine MoT of a promising trade lane. Since we are looking for the most promising trade lanes, we focus on the trade lanes with an above-average growth factor for CT volume. The mean value of the CT affine volume growth factors of the identified trade lanes is 6.58%. According to this procedure, the most promising trade lanes in the BSR are Denmark-Germany, Poland-Sweden, Sweden-Poland, Estonia-Finland, Finland-Poland, Lithuania-Germany, Lithuania-Sweden, Latvia-Poland and Estonia-Germany.

Figure 40 shows the development of CT affine volumes on these most promising trade lanes. The values for the 2013-2018 annual slices are taken from the respective data sets. The values for the 2030 forecast are formed taking into account the respective CT growth factor. The trade lane with the highest potential CT affine volume is Denmark-Germany with 35499kt. The trade lane with the highest growth factor for CT affine volumes is Finland-Poland with 16,63%.

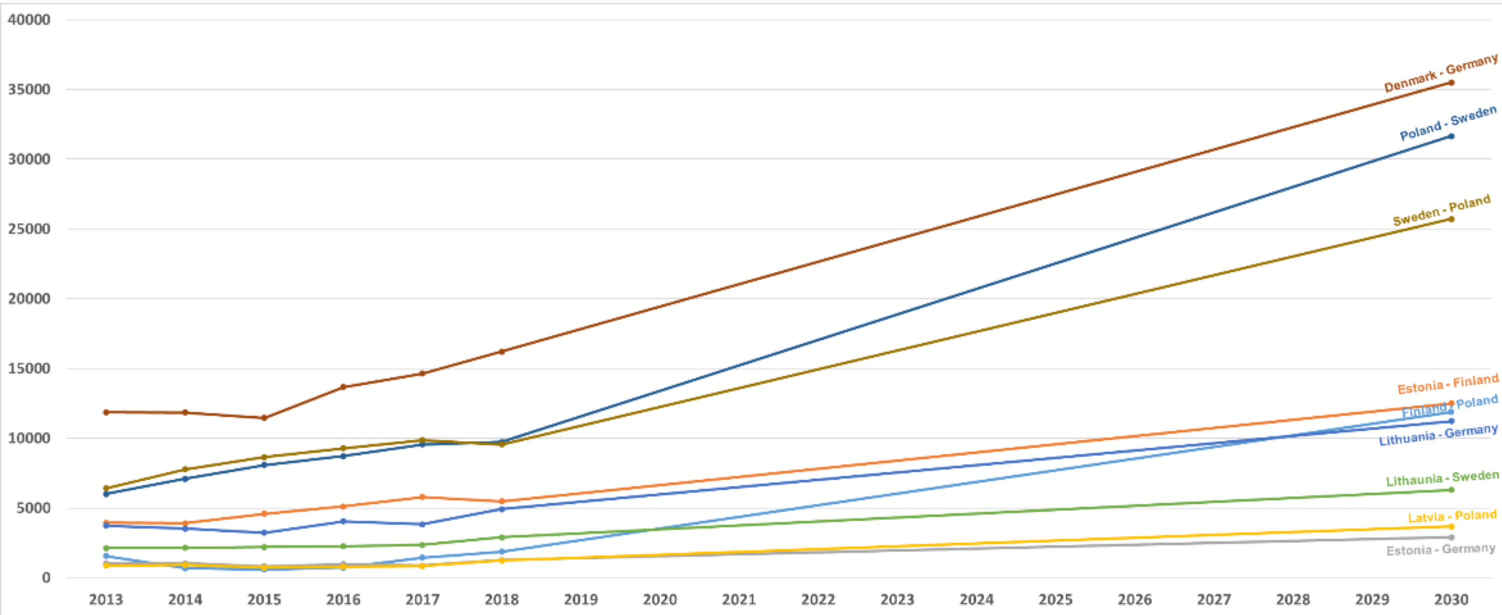


Figure 40 Development of CT-affine Volumes (kt) on the Most Promising Trade lanes 2013-2030 (own illustration)

Conclusion:

Figure 40 shows an estimate of possible CT affine volume potentials on the most promising trade lanes in the study area. The data situation on explicit CT volumes is complicated, even beyond the study area, data is partly incomplete and often difficult to compare. Research on CT transport regularly faces this challenge. We have opted for the approach of approximation and identified CT-affine volumes from available data as explained in the individual steps in order to derive forecasts of possible CT-affine volumes. The analysis contains data and technically weighted results from various studies and, due to its approximation character, makes no claim to completeness. Nevertheless, the result is valuable on several levels. On the one hand, the analysis leads to a selection of the most promising trade lanes in the study area, and on the other hand, the methodology can be adapted accordingly if the data situation improves in order to further increase the validity of the forecasts.

4 MOST PROMISING TRADE LANES TOUCHING BSR COUNTRIES FOR THE IMPLEMENTATION OF CT CHAINS BASED ON PARTNER INPUT

As outlined in 2.2 the project partners were asked to make suggestions on promising trade lanes. Two practical suggestions are presented in this chapter. The Sweden-Turkey trade lane is presented in 4.1. The proposal comes from the project partner LTG Cargo and refers directly to an international trade lane. Under 4.2 Kujawsko-Pomorskie Voivodeship presents its proposal. This is a partial regional trade lane on the Baltic-Adriatic Corridor.

4.1 Sweden-Turkey

LTG Cargo presents the Trade Lane Sweden-Turkey.

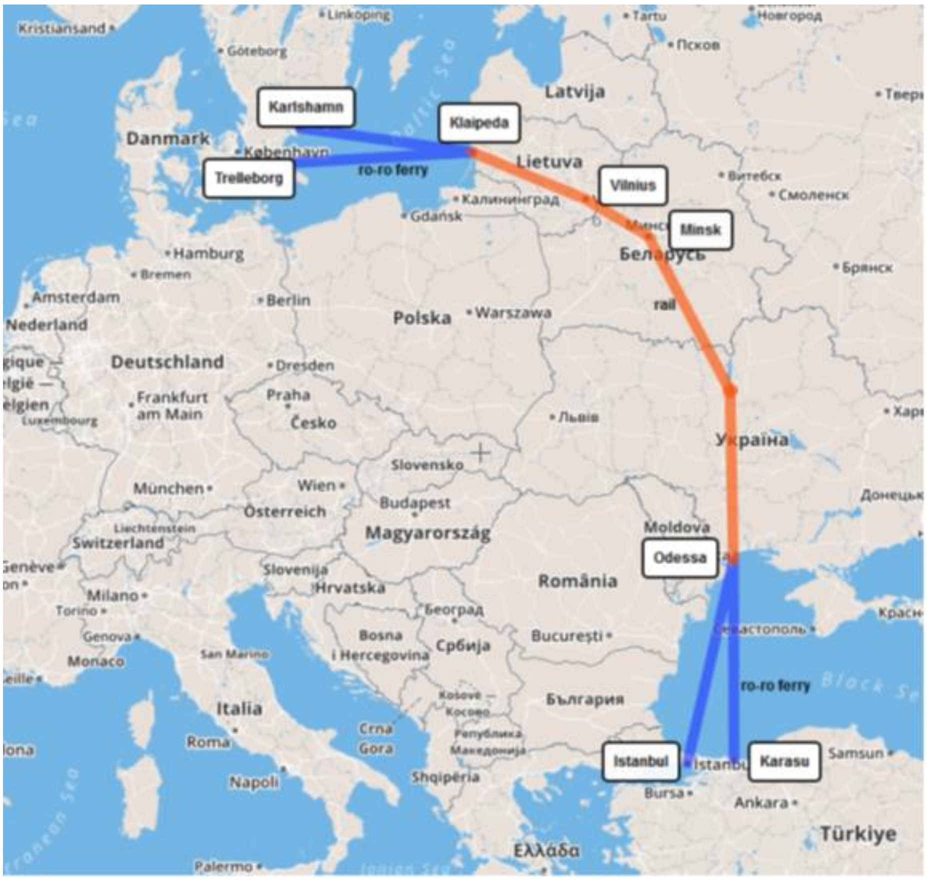


Figure 41 Trade Lane Sweden-Turkey (SGKV, own illustration according to LTG Cargo)

The trade lane starts in Sweden in Trelleborg and/or Karlshamn. Goods are transported via Ro-Ro ferry to Klaipèda in Lithuania. This is interesting and immediately underlines the relevance of the two different approaches from Chapter 2. The trade lane Sweden-Lithuania does not appear in the Swedens Top 10 O-D relations (see Table 2). At 2004 kt, the MoT maritime waterway is comparatively low. At the same time, Figure 42 shows the comparatively high Ro-Ro share of 70.9%.

Through the expertise of the partners, this ratio can now be interpreted qualitatively and with a view to future potential.

Figure 42:Type of Cargo for Maritime Waterway Sweden-Lithuania Export 2018 (Combine Project 2019)

From Klaipeda, the journey continues by rail via Vilnius and Minsk to Odessa.
The last section of the trade lane leads again by Ro-Ro ferry from Odessa to Turkey to the locations Istanbul and Karasu.
The trade lane thus combines the two MoT rail and maritime waterway in the form of Ro-Ro. The cargo group transported is semi-trailers. LTG Cargo estimates the total shifting potential from road to rail on the trade lane Sweden-Turkey at 20,000 semi-trailers or 40,000 TEU.

LTG Cargo continues to identify relevant part trade lane on the overall trade lane. These are the trade lanes Klaipeda-Vilnius (see figure 43), Klaipeda-Minsk (see figure 44) and Klaipeda-Odessa (see figure 45). The three part trade lanes are rail connections. According to LTG Cargo, 12,000 TEU were handled in Vilnius in 2018. This compares with a loading capacity of 100,000 TEU. There is therefore potential for expansion of CT traffic at this location.

Figure 43: Section Klaipėda-Vilnius

Figure 45: Section Klaipėda-Minsk

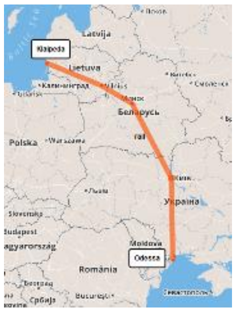


Figure 44: Section Klaipėda-Odessa

4.2 A promising trade route in the Baltic Sea region

An interesting example of the development of commercial trade lines in Europe is the transport corridor connecting the Baltic Sea with the Adriatic Sea and which has been one of the nine corridors of the TEN-T core network since 2013. For many years in the Baltic-Adriatic Corridor (BAC) many initiatives of member countries, as well as regions along its route, are being undertaken in the scope of developing line and point infrastructure, which is to improve the transport of goods in a multimodal system. Already at the beginning of the century, after the accession of Poland and other Central

European countries to the European Union, cross-border actions were taken to improve transport on the north-south axis connecting the Baltic with the Adriatic. On October 6, 2009, 14 regions representing Poland, the Czech Republic, Slovakia, Austria and Italy signed an agreement for the "immediate implementation of the North-South rail corridor". In turn, on 3.12.2009, 9 regions representing Poland, the Czech Republic and Austria signed a joint declaration expressing the European and regional significance of the Gdańsk-Brno-Vienna motorway axis. In response to the above agreements, on December 23, 2010, an agreement was signed in Gdynia between the marshals of seven Polish regions located along the route of the Polish part of the corridor. In the course of further work, a formula was established to strengthen cooperation in the form of an association, which resulted in the founding congress of the Association of Polish Regions of the Baltic-Adriatic Transport Corridor on 30/03/2012. The association was registered on 23/05/2012 and to this day actively promotes work related to the development of the corridor, among others by organizing the annual Corridor Forum in the form of conferences, participating in international activities related to BAC, as well as publishing the annual Report on the condition of line and point infrastructure.

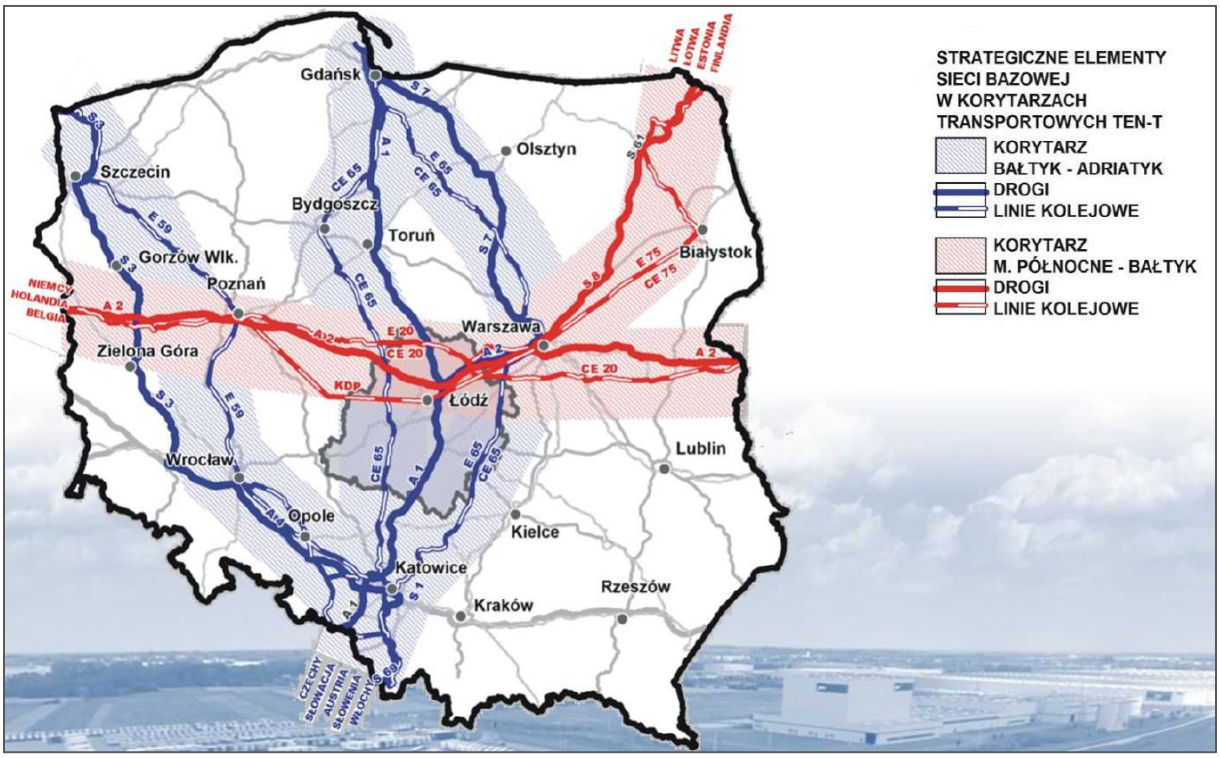


Figure 46: The Baltic-Adriatic and the North See-Baltic Corridors in Poland. Roads and railways.

One of the members of the Association is the Kujawsko-Pomorskie Voivodeship, which actively participates in the works related to the development of the Corridor (BAC), seeing the special transport potential on the section of the Corridor connecting seaports in Gdańsk and Gdynia with the Bydgoszcz Logistic Node planned in the region. The development and launch of regular combined transport on this section should be a pilot task and be subject to a broader analytical study. As a region, we believe that every corridor should be served by multimodal transport streams based on road, rail, air and water transport. Poland's ratification of the AGN Convention has created formal conditions for applying for the inclusion of inland waterways of international significance to these corridors and for financial support for the implementation of infrastructure projects related thereto. Poland located in the central part of Europe has very favorable conditions for the development of intermodal transport. Within the country, two main European transport corridors intersect, on which transit transport is based. This is undoubtedly a challenge for Poland, but also a great opportunity. The shipping industry should do everything to make money on the transit position of the country and make attempts to include water routes in the corridors as soon as possible, because many trade routes pass through Poland. This is an opportunity for the development of international exchange of goods.

At present, the core network on the section Gdańsk / Gdynia - Bydgoszcz includes: the A1 motorway and railway line No. 131 (Chorzów Batory - Tczew) in the scope of freight railway lines intended for expansion. To the comprehensive network: S5 express road and railway lines: No. 131 (Chorzów Batory - Inowrocław - Tczew), 201 (Nowa Wieś Wielka - Maksymilianowo) and 353 (Poznań - Inowrocław - Toruń - Skandawa) in the field of passenger transport, as well as the Airport in Bydgoszcz. To comprehensively use transport on the section, the Self-Government of the Kujawsko-Pomorskie Voivodship has been actively seeking for many years to enter the TEN-T network of inland waterways of international significance, i.e. MDW E40 and E70 and the Bydgoszcz Logistic Node to the core network.

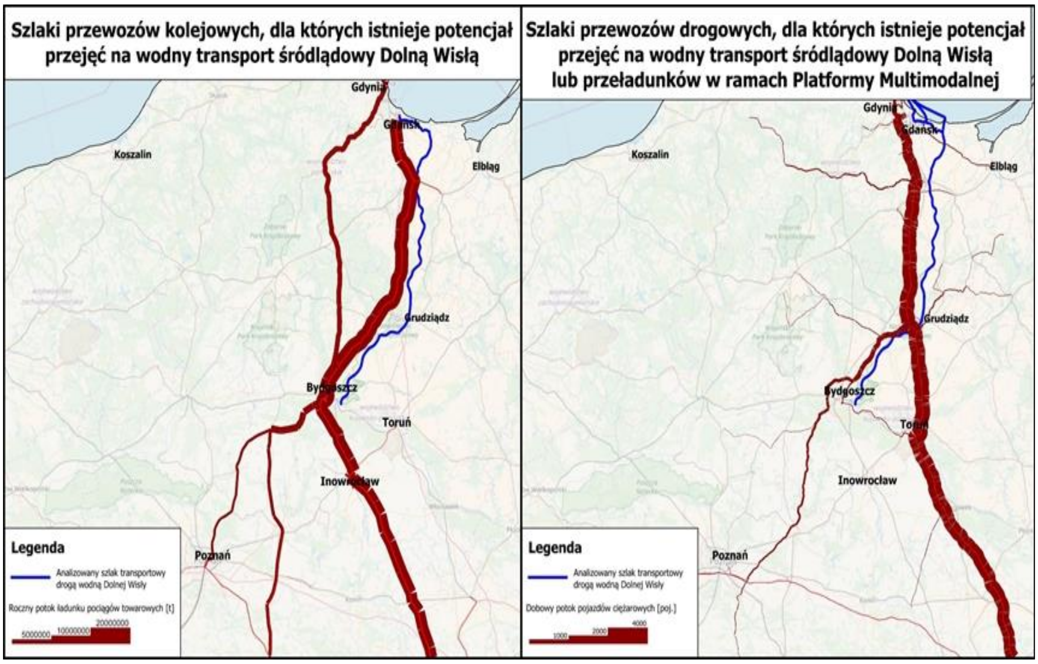


Figure 47: Rail and road transport routes for which there is potential for takeovers for inland transport by the Lower Vistula River.

The analyzes carried out earlier show that the accelerated growth of transshipped goods in the seaports of Gdansk and Gdynia (forecasted in 2050 around 130 million tons) will not be supported by only two modes of transport. An alternative option in this case is to transfer some of the loads from roads and railways to inland waterway transport. Detailed data is presented in the table below.

Rodzaj ładunku	Takeovers from road transport	Takeovers from rail transport
containers [t/y]	150 433	215 738

dry bulk loads [t/y]	125 901	325 318
other loads [t/y]	13 320	43 306
sum	289 654	584 363

Table 12: Takeover potential for inland waterway freight for various transport groups in the base year [t / year].

Studies of scientists from the University of Gdańsk in this case, in turn, say about 7-12 million tons of goods distributed annually on this section only by inland waterway in 2050. Due to the above situation, as part of the EMMA project, the KPV together with the City of Bydgoszcz developed a Location Study for the Multimodal Platform Bydgoszcz-Solec Kujawski. The platform would function as an internal port for seaports in Gdynia and Gdańsk, where the existing capacity of access infrastructure (road and rail) is slowly running out and there is no possibility of further expansion due to highly urbanized areas. The estimated forecast of transshipments made as part of the Bydgoszcz-Solec Kujawski Multimodal Platform, taking into account local potential and takeovers for inland waterway transport, taking into account all aspects that may affect transport, would ultimately amount to approx. 3 million tonnes per year, which would undoubtedly affect the relief of road and rail transport. The most important aspect for the whole project will undoubtedly be the conditions resulting from the accessibility of the lower Vistula waterway and the existing navigation conditions. In the course of the study conducted by the contractor, it should be stated that navigation on the Vistula should be operational from March to November, i.e. about 270 days a year. During the remaining approx. 90 days of the year, the conditions for navigation are unfavorable due to the occurrence of lows, highs and ice conditions.

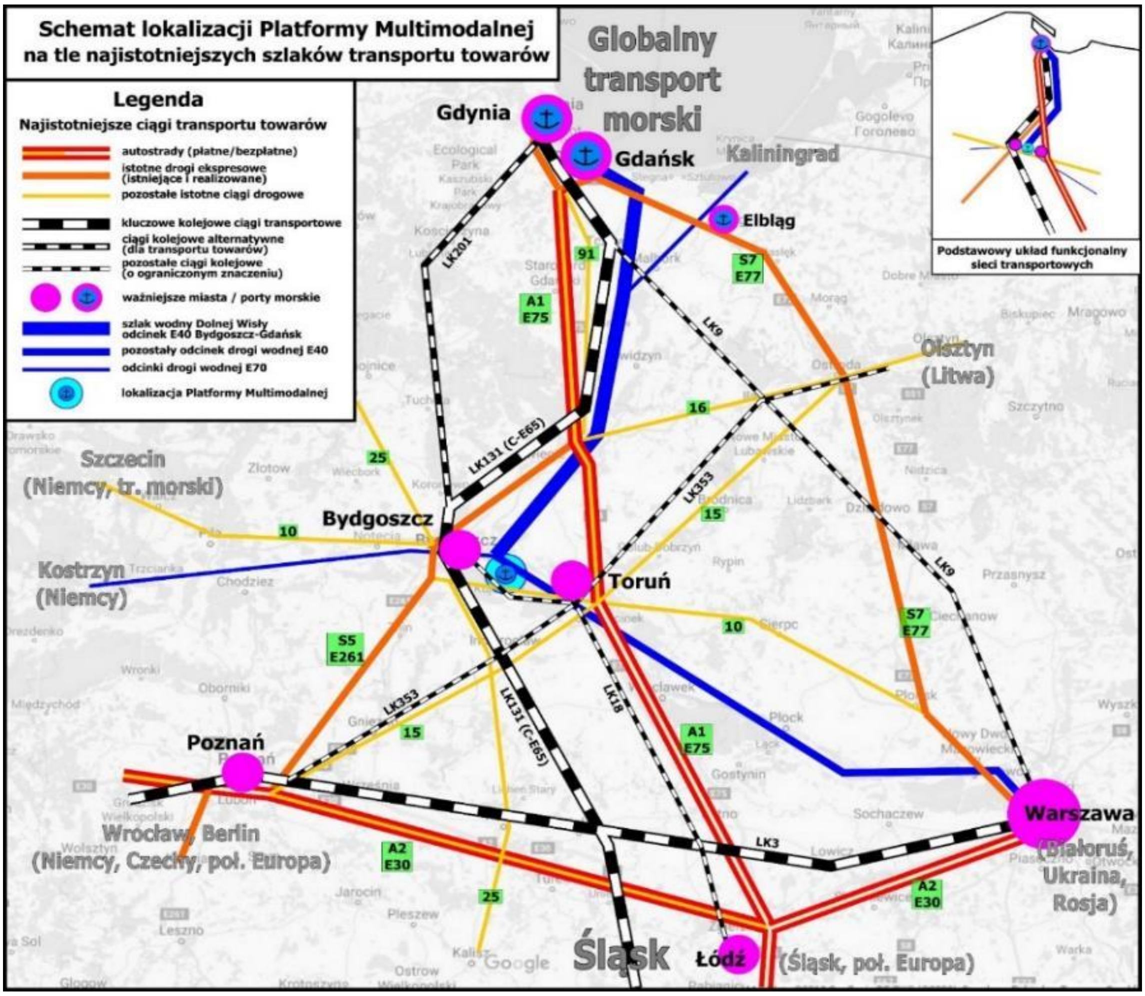


Figure 48: Multimodal Platform in Bydgoszcz location scheme towards important transport routes.

This investment, along with the intermodal terminal in nearby Emilianowo (10 km south-east of Bydgoszcz), will create one Logistic Node Bydgoszcz. The implementation of the logistics node construction and its integration into the TEN-T core network will be a model example of the use of sustainable and efficient transport. At the same time, as part of the COMBINE project, we are in the process of developing the Last mile concept for the Bydgoszcz Logistic Node. As part of the commissioned work, the following analyses are expected: supply chains between the main logistics centers in the country and in the relationship Kujawsko-Pomorskie Voivodeship - Western Europe, Eastern Europe, Scandinavia and China, as well as distribution of goods within the last mile of the Node itself. This material could be an input for a broader development of development trade routes resulting from the COMBINE project application, and maybe also subjected to a project pilot (this fact is supported by the participation of 3 partners from Poland in this area, i.e. the authorities of the Kujawsko-Pomorskie Voivodeship, authorities the city of Bydgoszcz and the University of Gdańsk), in terms of optimizing the change of transport mode, increasing the work efficiency of terminals and last mile transport.

4.3 Spatial analysis of BSR and case study terminals for implementation of CT chains

SGKV performed a spatial analysis of the two case study terminals in Sweden of the Baltic Sea Region as discussed in the previous section, to provide a better understanding of the combined transportation flows, structure, and market conditions. In this regard, a framework was created in a Geographical Information System (GIS), with relevant infrastructural data that enables to highlight the advantages and gaps of the region. A focused effort was made to source these data from open sources as listed in the Literature section of this report, to enable broad usage by all interested stakeholders form the region.

The framework consists of different transport networks like railways, waterways, and roadways, apart from the CT terminal database from SGKV. The project also utilized national case studies by including commercial and industrial areas for isochrone analysis. QGIS was used to create a GIS based framework for map representation. The visualizations created using these tools can be used for spatial and statistical analysis as demonstrated in the examples described below. As an overview to the Baltic Sea Region, the Figure 52 below represents the terminal density in different states of the Baltic Sea Region.

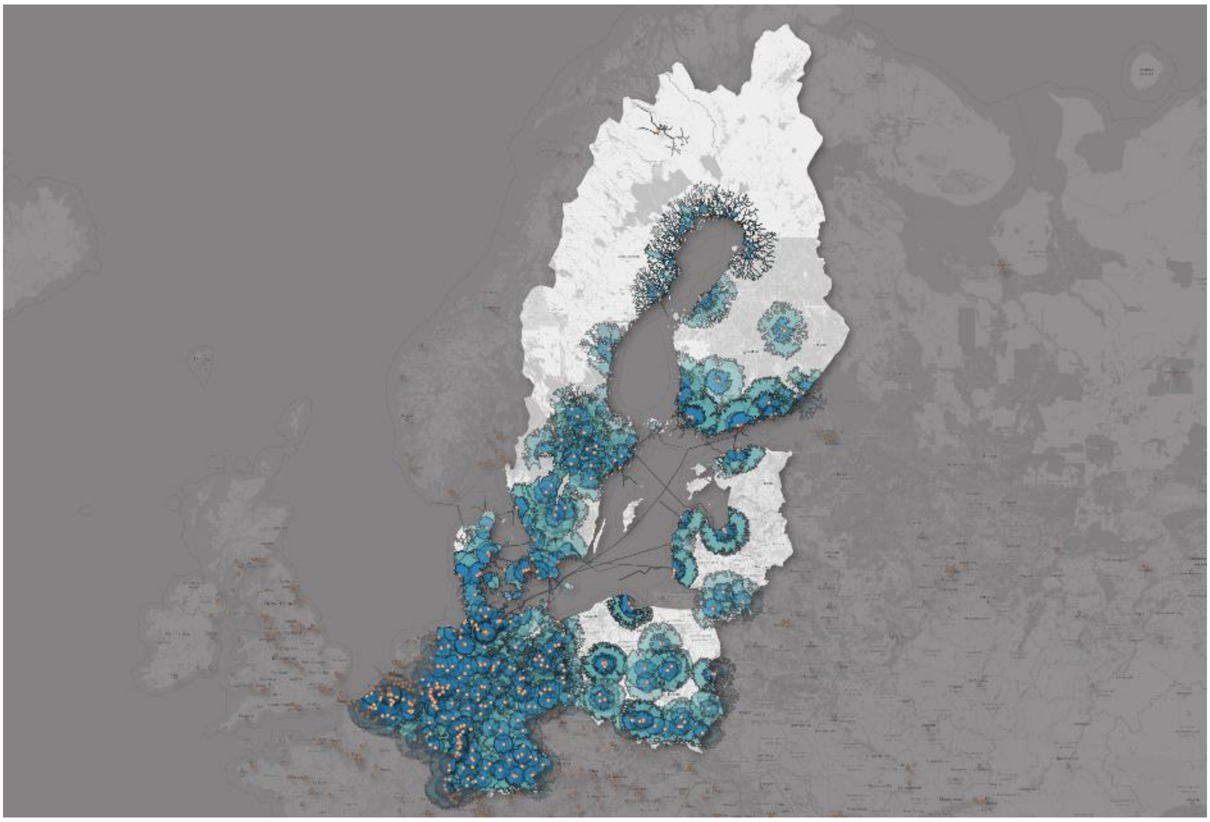


Figure 49 Baltic Sea Region – Terminal density and Travelling distances (Own illustration)

The various CT terminals of the Baltic Sea Region were chosen for this analysis from the SGKV CT terminal database, Intermodal Map. Then using QGIS, these terminals were visualized on the background of the Baltic Sea regional states for a first understanding of the density of terminals. It is clear from the above image that Germany has the densest CT terminal network among the different states.

To gain a deeper understanding of the region, SGKV created a set of isochrones around these terminals considering a travelling speed of 50 km/hr. Two isochrones for 30 minutes of travelling distance and 60 minutes of travelling distance were created for getting a wholesome picture of CT infrastructure including first/ last mile connections. This visualization helped to identify the vast scope available in many of the Baltic Sea Regions to further develop the CT related infrastructure to promote adoption of CT chains.

A similar analysis was performed for the case study terminals of Trelleborg and Karlhamns Hamn in Sweden. In addition to these two terminals, another major CT terminal in the vicinity called Arken Norra – Gothenburg was included in the study. Here the isochrones were created in three levels namely, 30 minutes, 60 minutes, and 90 minutes approximately. It once again corresponds to 50 km/hr, translating into 75 km for 90 minutes. These isochrones are based on the consideration that one drives heavy good vehicles on the road network. This visualization enables to understand the first and last mile catchment areas of these three CT terminals towards creation of CT chains. Furthermore, it also brings to light the opportunities existing for the development of new CT infrastructure to provide seamless coverage to freight users based on the commercial and industrial land use patterns superimposed on the map. Apart from these analyses, the study also incorporated the Trans-European Transport Network (TEN-T) consisting of the Scandinavian to Mediterranean road and rail networks for a holistic understanding of the access to these terminals. A snapshot of the Geographical Information System analysis is represented in Figure 53 in the following sections.

After analyzing the overall situation of the Baltic Sea Region with respect to existing CT infrastructure and then taking a closer look at three case study terminals, study then focused on the future development of the market. The Eurostat data of real growth rate of regional gross value added (GVA) was considered as the basic to generate a prognosis for the future development based on the current situation. To relate with the CT infrastructure, the CT terminals database from SGKV, the Eurostat GVA data and the transportation networks were visualized for the case study terminals of the BSR as shown in Figure 54 on the next page. The rail, water, and road network were sourced from the EuroGlobalMap, UNECE, and again the EuroGlobalMap respectively. The visualization helped to conclude that based on the regional growth rate in terms of gross value addition, many BSR states such as Poland, Denmark, Sweden, among others were growing and presents an opportunity for further development of the CT infrastructure and transport chains. Such analyses enable the various stakeholders in the CT market to develop their strategy in line with the market and promote increased modal shift to sustainable combined transport in the Baltic Sea Region.

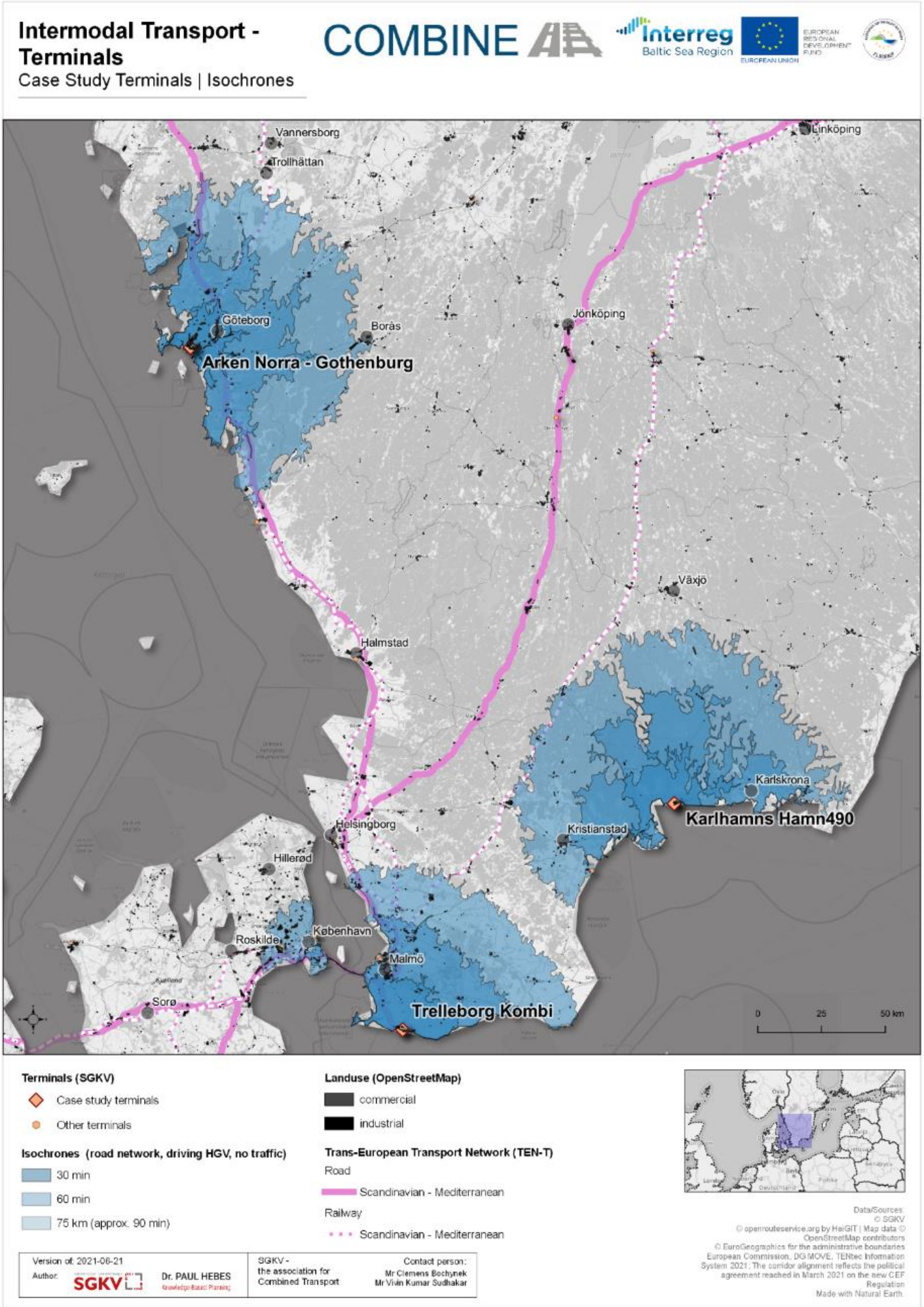


Figure 50 Case Study Terminals – Distances, Market, TEN-T Corridors (Own illustration)

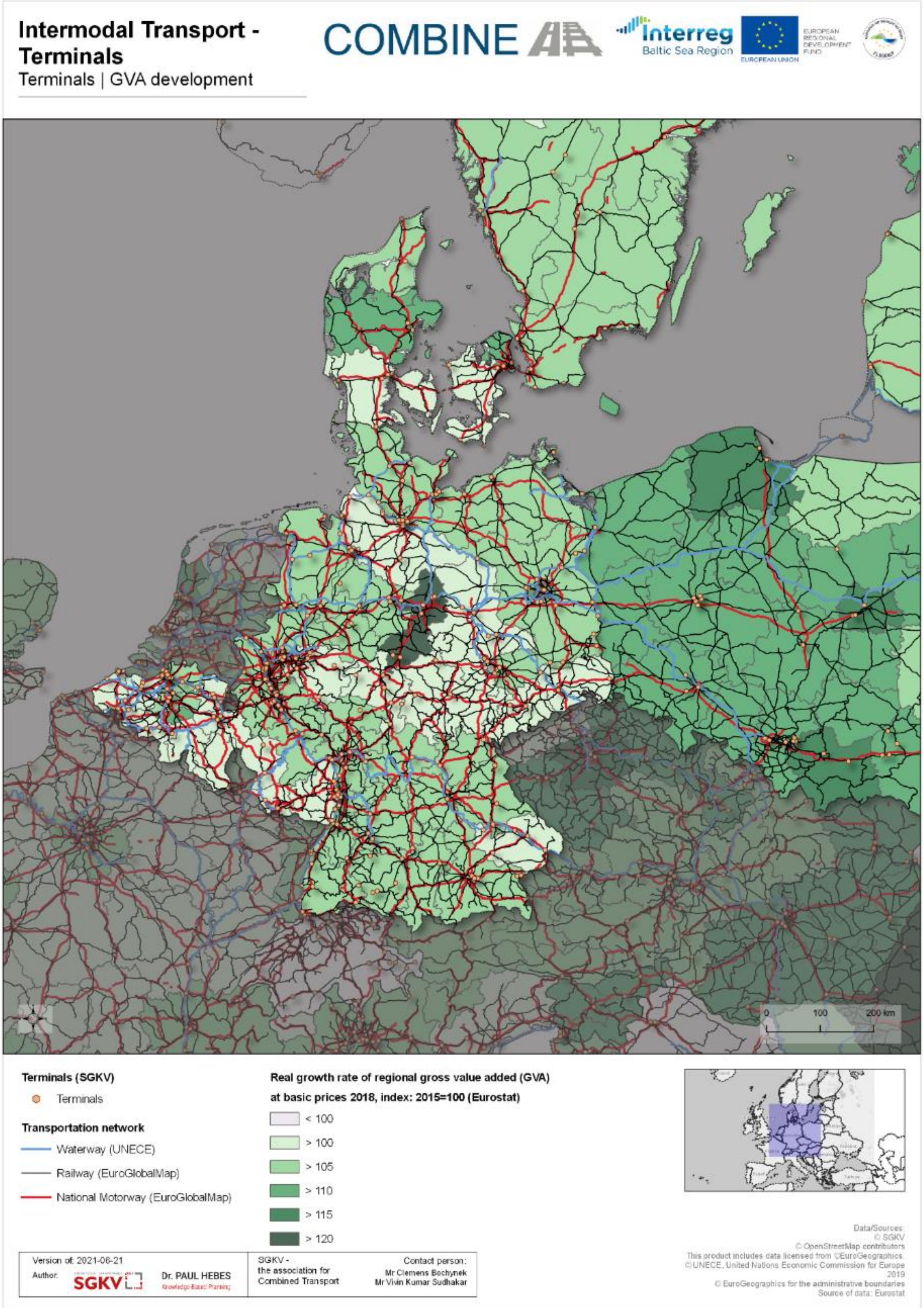


Figure 51 Case Study Terminals – Growth rate of regional gross value added (Own illustration)

5 PILOT PROJECTS

5.1 CT TRIAL RUN: A pilot project in 1520 mm rail system by Normunds Krumins and Egons Mudulis; Latvian Logistics Association

5.1.1 Introduction

Intermodal, combined transport (CT, e.g., semitrailers carried on railroad) transport is not properly prescribed in Latvian legislation (except container transportation), does not receive any substantial financial or non-financial support (see WP 5), and in fact currently is not functioning at all. There are neither appropriate railway wagons nor competitive rail infrastructure charges. It costs at least twice as much to send a semitrailer by rail than on the road through Latvia, as members of the Latvian Logistics Association (LLA) have calculated in 2019.

Both business and government, however, are interested in promoting combined transport.

5.1.1.1 Business interest

Regional retailers have been sending dozens of lorries from Latvian capital Riga to Estonia and Lithuania each day. As driver availability has been a huge problem, transporting semitrailers on railway platforms, except last mile, would be welcome solution for different companies. A competitive CT service is of interest also for a ferry service provider Stena Line connecting Latvian ports with Germany and Sweden. Among other things that – no need to transport lorries, just semitrailers – would improve its use of ferry capacity and create an economic benefit, too.

5.1.1.2 Government interest

The government in turn is interested in less cargos on road (infrastructure maintenance and environmental factors) and more cargoes on rail (Russian transit, especially coal and oil products, is falling rapidly). The Ministry of Transportation (MT), and the Minister of Transportation of Latvia Mr. Talis Linkaits himself had expressed their interest in promoting intermodal transport as much as possible.

According to the data of MT (https://www.sam.gov.lv/en/statistics), cargo turnover on Latvian railway system dropped substantially by 45.5% to 19.2 million tons, and in seaports by 29.5% to 37.3 million tons mainly due to decrease of coal by 78.5% to 3.2 million tons and oil products by 20.4% to 9.2 million tons in 10 months of 2020 comparing to the same period in 2019. The falling numbers make both business and government to look for other possible cargos.

5.1.1.3 Project tasks

As COMBINE project aims at enhancing the share of CT in the Baltic Sea Region to make transport more efficient and environmentally friendly, the project was appropriate framework to increase awareness of CT benefits by organizing a pilot project – a CT trial run from Russia to Germany via Latvia.

As COMBINE project plans to strengthen all parts of the transport chain, and look at new technologies regarding these different parts of the transport chain, the trial run was intended:

- to test technology, i.e., new CT railway wagon and describe real handling process in Latvia;
- to cross the EU external boarder, that would reveal any issues involving customs, differences in treatment of “transport on transport”, i.e., semitrailer on a wagon;
- to evaluate overall feasibility, i.e., the time spent on the route, costs, including current railway tariffs, safety of the process.

The potential data gathered during the project was considered to be key for suggesting changes in Latvian legislation in order to make CT possible and feasible.

5.1.2 Project description

It was planned to carry out an international pilot project (route from Moscow to Germany) that envisages the European Union border crossing (Russia–Latvia) by rail, short sea shipping, and new rolling stock and handling technology, i.e., new special intermodal wagon with new handling technology from the First Federal Intermodal Freight Operator (FFIFO, Russia).

A semitrailer was put on the specialized wagon in Russia and sent to the Latvian port of Liepaja by rail. To lift the semitrailer a reach stacker, an adjusted metal frame, and ropes were used.

5.1.2.1 Participants

The following organizations and companies were involved in the project: the LLA, Stena Line (ferry connection from Liepaja to Travemund), DB Schenker, LDz Logistics (a daughter company of the Latvian Railway), First Federal Intermodal Freight Operator (FFIFO, Russia, supplying new special intermodal wagon with new handling technology), Terrabalt, an intermodal terminal at the Port of Liepaja.

Figure 52: Lifting semitrailer at the port of Liepaja. © Stena Line

5.1.2.2 Technology

The rolling stock used in the project was a brand new (built in 2020) wagon developed by FFIFO and certified for the use within entire 1520 mm railway system. It is intended to carry both containers and semitrailers. The wagon may reach maximum speed of 120 km/h, carry 24,44 t of cargo, and its full weight may reach 69 tons.

Figure 53: The specialized wagon at the port of Liepaja. © Stena Line

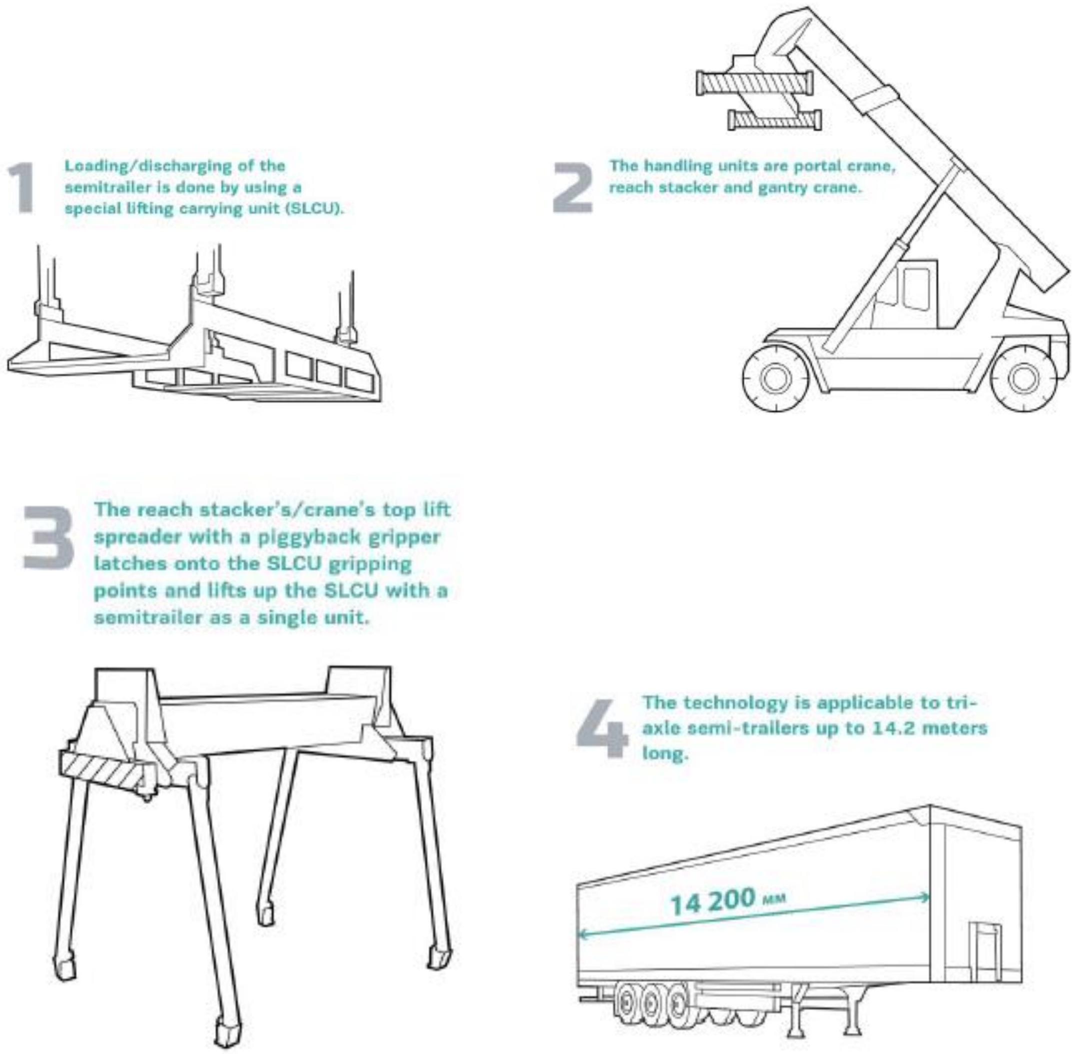
5.1.2.3 Handling equipment

The handling is carried out as seen in the following figures. Loading and discharging (1) of the semitrailer is done by using a special, basket-like lifting carrying unit (SLCU).

The handling units are any of the following: portal crane, gantry crane or reach stacker (2).

The handling unit's top lift spreader with a piggyback gripper (3) latches onto the SLCU gripping points and lifts the SLCU with a semitrailer as a single unit. As mentioned before, in Liepaja reach stacker and ropes were used to lift the cargo

The technology is applicable to tri-axle semitrailers (4) up to 14.2 m long.



5.1.2.4 Challenges

The pilot project faced some organizational difficulties as Russian customs thought to consider the wagon with the semitrailer as two transport vehicles, i.e., they looked upon and treated the semitrailer not as a cargo. Solution, however, was found by re-routing the wagon via Belarus. That worked because Belarus had had certain previous experience with CT, e.g., with Lithuania. (In that case, however, semitrailers with trucks were transported on adjusted platform.)

As of the end of 2020 there were still no proper instructions for the Customs Union (Russia, Belarus, Kazakhstan) how to deal with CT. Nevertheless, the semitrailer was declared as a cargo.

5.1.2.5 Timeline

Initially there were some delays in carrying out the pilot project. It took longer than expected to certify the appropriate platforms in 1520 mm rail gauge area. It was planned to carry out the project in March 2020, however, the Covid-19 pandemic complicated the situation, too. As organized public gatherings of more than two persons were forbidden in Latvia plans to make the project a public event could not be realized in the spring of 2020. Finally, the project was publicly presented at the Port of Liepaja on August 3, 2020.

As far as the time necessary to carry the project out, it took 5 days for the single wagon to reach Liepaja from Moscow. Thus it was estimated that the transit time for a single wagon could be 4–6 days in general. In case of a block train, however, (considering transit time of existing container trains) it would take 50–55 hours to make the distance. Besides some 27 hours were necessary to take the semitrailer by ferry (Stena Line offers a regular timetable on the route) from Liepaja to Travemunde.

5.1.2.6 Costs

The data obtained by the pilot project (see table 1) show that to send a semitrailer by railway as a single wagon from Moscow to Liepaja and then by a ferry to Travemunde in 2020 could cost up to 1250 EUR.

First and last mile transportation brings additional costs depending on distance.

Russia		Latvia		Ferry	Europe	
Pre-carriage Road short (up to 200 km) 200 EUR	Intermodal Rail Moscow – EU/LV Border 300 - 350 EUR (existing)	Intermodal Rail EU/LV Border - Liepaja 290 - 310 EUR (existing)	Terminal Operations Liepaja 46 EUR	Liepaja (LV)- Travemunde (DE) Max 500 EUR	Terminal Operations Travemunde Pre-carriage 46 EUR	Intermodal rail Travemunde - Duisport 305 EUR
Pre-carriage 46 EUR Road Long 0,6 EUR/km						Intermodal rail Travemunde – Duisport 305 EUR

Table 13: Costs of the pilot project

5.1.3 Support for CT

In connection with the trial run the LLA came up with some legislation initiatives to support the development of CT in Latvia.

5.1.3.1 Rail

LatRailNet (performs essential functions of the public railways infrastructure manager) has been open to a special railway infrastructure tariff for CT in Latvia.

Russia is considering a 30% discount for CT comparing with container transportation on Railway.

5.1.3.2 Road

After the pilot project the LLA sent a letter to Ministry of Transportation where suggested a couple of changes in the existing legislation, taking as a basis best practices in Sweden.

Legislation suggestions

The essence of the offered bills:

- To increase maximum weight for vehicle compositions with a semi-trailer which consists of a two-axle towing vehicle and a three-axle semi-trailer, while conducting intermodal transport or CT operations, from 40 to 42 tons.

- To increase maximum weight for vehicle compositions with a semi-trailer which consists of a three-axle towing vehicle and a two-axle or three-axle semi-trailer, while conducting intermodal transport or CT operations, from 40 to 44 tons.

- To increase maximum length of vehicle compositions, in case the European Modular System (EMS) is used while conducting intermodal transport or CT operations, from 18.9 m to 25.25 m with maximum weight of 60 tons.

The Secretary General of the association of Latvian road haulers Latvijas Auto expressed his interest in and support of the LLA bills.

After two online discussions in October and November of 2020 with stakeholders the MT was ready to proceed immediately with increasing maximum weight for CT vehicle compositions because that would require only slight changes in Latvian Road Traffic Regulations.

To increase maximum weight and length for vehicle compositions used in EMS the Law on Carriage by Road should be opened. To do that, however, MT believed certain consensus should be reached among stakeholders, including Road Traffic Safety Directorate and infrastructure manager Latvian State Roads.

Effects of the bills

Some 100510 semitrailers or trailers were carried by ferries between Latvia (Ventspils, Riga) and Sweden (Nieneshamn, Stockholm) according to Central Statistical Bureau of Latvia. If Latvia introduced maximum length and weight requirements as in Sweden it would decrease the necessity of truck journeys by third and consumption of fuel by approximately 15%. That in turn would be contribution to the Transport Development Guidelines 2021 – 2027 which are being prepared now. The guidelines envisage to give “contribution to the economic growth of the country, including in the development and accessibility of the business environment”. Decreasing the number of truck journeys would meet some tasks (air quality, climate change, noise) of the draft Strategic Environmental Assessment Environmental Report as well.

According to the Guidelines, “Transport policy aims at an integrated transport system that ensures safe, efficient, intelligent and sustainable mobility, promotes the country’s economic growth, regional development and contributes to the transition to a low-carbon economy."

5.2 Analysis of the implemented pilot “semi-trailers in the BSR” (LTG CARGO)

The pilot project was executed by LTG CARGO through an external supplier / sub-contractor. The summary of the project results as produced by LTG CARGO is as follows.

5.2.1 Goals of the test-run of train

At a first stage transportation simulation model has been prepared, i.e., a theoretical plan for transportation of semi-trailers by rail in Baltic Sea Region via Germany, Poland, Lithuania, Latvia, Estonia, and Finland (hereafter – the corridor). For a second stage a real test train has been organized on part of the corridor i.e., from Germany to Lithuania via Poland and back.

The main goals of the actual test according to the model were to:

• Test and validate or reject main assumptions of the simulation model.

• Identify economical, technical, and technological, legal, social, administrative, and other obstacles to the organization of the test trains on the corridor.

• Prepare proposals and recommendations on the organization of trains for the transportations of semi-trailers by railways in the Baltic Sea Region.

5.2.2 Current situation and constraints

Currently there are no existing commercial services for transportation of semi-trailers on the corridor except for some semi-trailers being added onto container trains traveling from Germany to inland terminals in Poland (for example Poznan). The corridor is vastly dominated by trucking services. According to data from Lithuanian transport administration annually there are approx. from 25 to 30 million tons of cargo crossing Lithuanian/Polish border by trucks whereas only approx. 0,5 tons transported by rail on average. Only approx. 1,6 % of total cargo volumes are being transported by rail. This low model split is more than 10 times smaller comparing to European average. According to UIC report on combined transport in Europe published in 2020 there are approx. 18 % of cargo transported by rail in distances grated than 300 kilometers (see Figure 57).

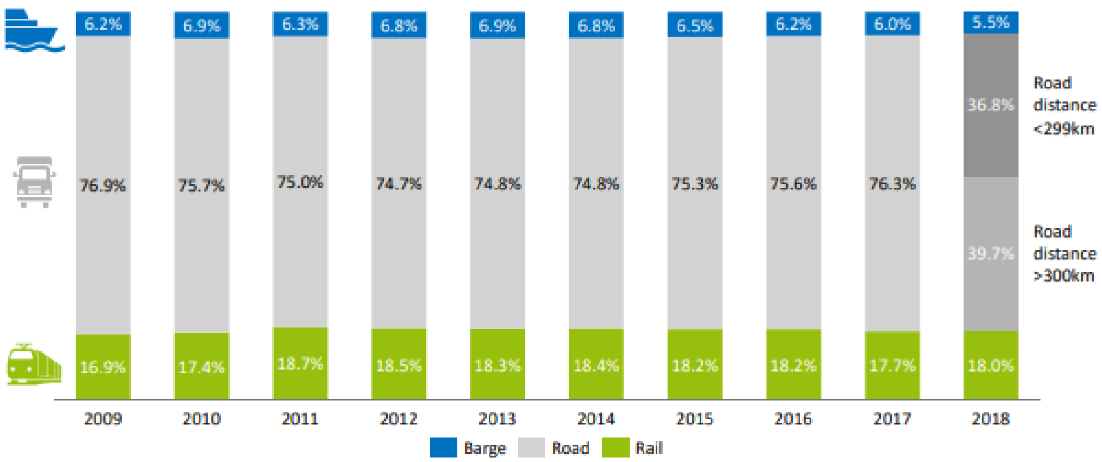


Figure 54: Development of rail’s share in modal split European freight transport (in % of tkm)

Source: 2020 Report on Combined transport in Europe, UIC.

This low cross country rail transportation ratio exists despite well-developed rail transportation in all countries on the corridor. Poland, Lithuania, Latvia, Estonia, and Finland have a total modal split well above 25 % with Germany being only slightly below (see Figure 58).

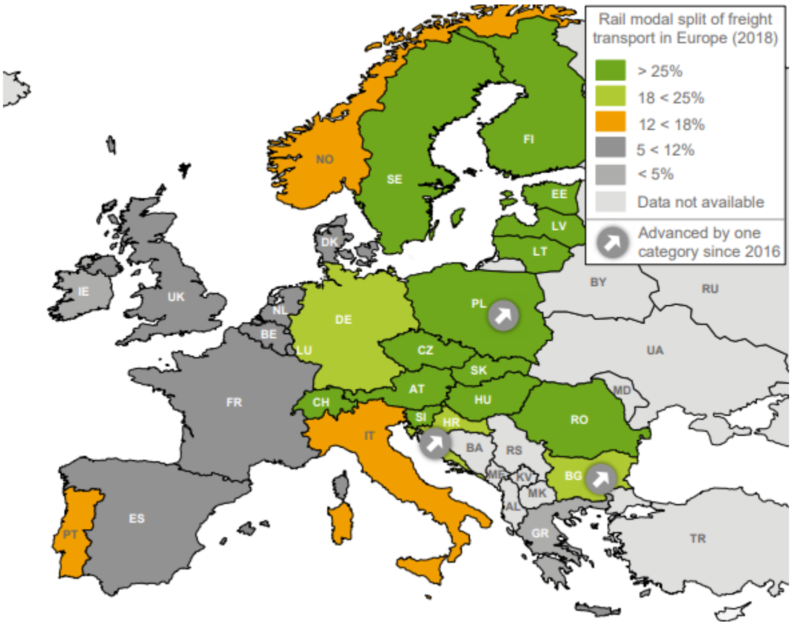


Figure 55: Map of rail modal split of freight transport in Europe by country in 2018 (% in total inland freight tkm)

Source: 2020 Report on Combined transport in Europe, UIC.

Main factors contributing to such a low modal split on the corridor comparing to other directions are different railway gauge; lack of transshipment terminals and craneable trailers.

5.2.2.1 Different railway gauge

There still is two different railway gauges and railways systems between Baltic states with Finland and Poland with Germany, i.e., 1520 mm width and 1435 mm width gauge networks. It is not possible to be running same locomotives and wagons on the corridor. Cargo needs to be reloaded every time.

However, situation is set to change quite soon with implementation of Rail Baltica project which is a greenfield rail transport infrastructure project with a goal to integrate the Baltic States in the European rail network. The project includes five European Union countries – Poland, Lithuania, Latvia, Estonia and indirectly also Finland. It will connect Helsinki, Tallinn, Pärnu, Riga, Panevežys, Kaunas, Vilnius, Warsaw. There will be three Rail Baltica terminals: Kaunas, Salaspils and Muuga and freight trains will be able to go in up to 120 km/h speed and maximum length of trains will be 740 meters. After implementation of the project there will not be needed to make additional reloading of cargo onto another gauge wagons.

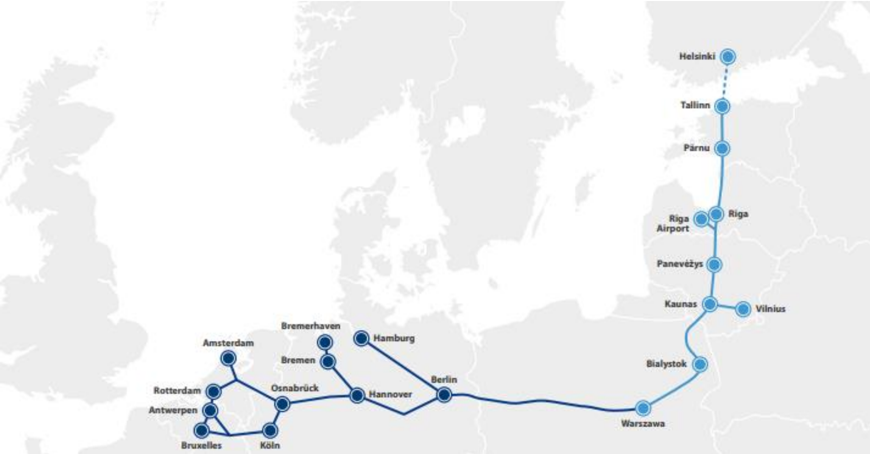


Figure 56: Map of Rail Baltica

Source: www.railbaltica.org

5.2.2.2 Lack of transshipment terminals

Currently there are no proper possibilities to be transshipping cargo from different gauges on the corridor. Up until now there has been only one terminal for reloading cargo between 1520- and 1435-mm width gauges. It is Sestokai terminal located in Lithuania approx. 20 kilometers from Polish border. The terminal has always been used for reloading of logs, military vehicles, and containers. No facilities exist to be reloading bulk cargo.

However, situation is changing for better as new terminal for reloading liquid cargo has been opened in Mockava station (LT) in 2017. In addition to that, 1435 mm width gauge connection has been finished until Kaunas intermodal terminal in 2021 opening possibilities to be sending intermodal trains with containers and/or semi-trailers to Kaunas, a second largest city in Lithuania. Kaunas is located right at main railway and road transport corridors crossing Baltic states what enables after reloading for cargo to be transporter further either by road or by rail. However there still are very limited possibilities to be transporting semi-trailers by rail further towards Finland as there is no specific wagons widely in use for transportation of semi-trailers on 1520 mm width gauge network although there are new models recently created and pushing into the market. Russian enterprise called “FIRST FEDERAL INTERMODAL FREIGHT OPERATOR” (FFIFO) recently presented new model wagon for transportation of semi-trailers (inc. the non-crane-able semi-trailer). Loading/discharging of the semitrailer is done by using a special lifting unit/pallet (see Figure 60).

Figure 57: FFIFO wagon for semi-trailers in operation

Source: https://seanews.ru/

In addition to that, “LTG CARGO” is also developing new technology enabling transportation of semi-trailers on regular 1520 mm width gauge flat wagons. The wagons are planned to be used on “Amber train” route which is a joint project of national railway freight transportation companies of Estonia, Latvia and Lithuania connecting three Baltic states by regular intermodal service. At the end of the connection is Muuga (near the capital Tallinn) terminal operated by Hamburger Hafen und Logistik AG (HHLA) TK Estonia. The terminal is market leader in container handling in Estonia and also handles Ro-Ro. There are “Tallink” Ro-Ro ferries running from Muuga to Vuosaari (Finland) several time per day providing excellent possibilities to reload semi-trailers directly into ferry going to Finland as Muuga terminal is well connected to the railway line as well.

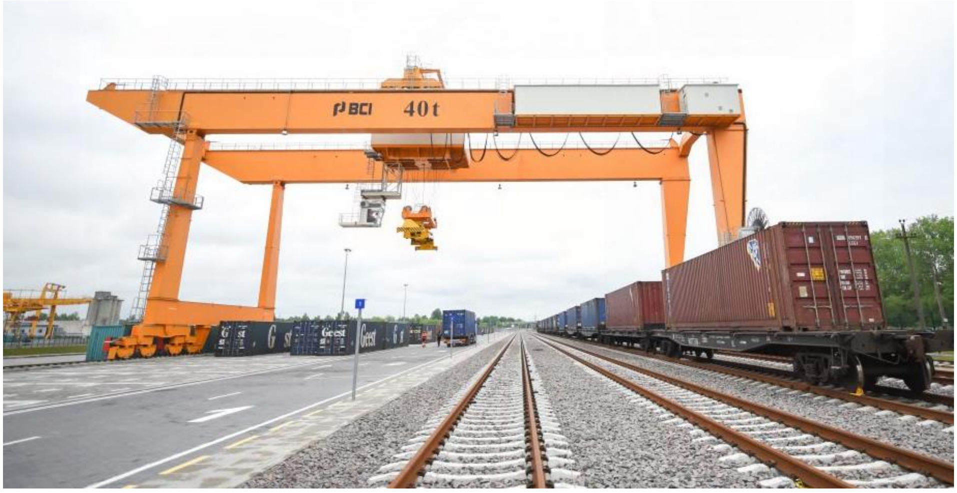


Figure 58: Kaunas intermodal terminal

Source: www.litrail.lt

5.2.2.3 Lack of craneable trailers

Another critical factor for development of semi-trailer transportation is for the clients to have semi-trailers in their fleet that could be lifted by gantry crane or reach stacker, i.e., craneable trailers. According to UIC report (see Figure 62) there are approx. 32% of craneable trailers on average in fleets of European carrier. However, a survey of potential users of semi-trailer transportation service has shown that among the potential users, i.e., Lithuanian, and Polish trucking companies, there are almost no companies that would have craneable semi-trailers on their fleet. This situation creates necessity to be using special technologies that would enable to be loading and transporting non-craneable trailers by rail.

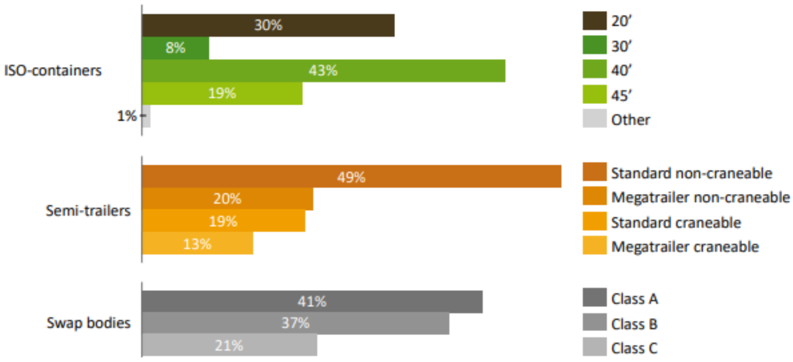


Figure 59: Structure of current intermodal loading units in European combined transport

Source: 2020 Report on Combined transport in Europe, UIC.

5.2.3 Test transportation

5.2.3.1 Schedule

Test transportation was started from Germany (terminal in Kaldenkirchen). The train was loaded in terminal on 29th of May. Loading of the train with semi-trailers in Kaldenkirchen was done very smoothly and took only 3 hours. After the trailers were loaded onto the wagons, the train was shunted to the departing station Kaldenkirchen Gl. 11 and left the station at 17:59 local time. It took until 1'st of June 09:10 for the the train to arrive in Kaunas intermodal terminal for loading. A detailed schedule is provided in figure.

Total distance of the transportation covered 1575 kilometers in total: 705 kilometers in Germany and 870 kilometers in Poland and Lithuania. It was covered in more than 63 hours although according to initial estimate total travel time should have taken only approx. 40 hours. Main factor causing such a big delays was infrastructure upgrading works in Poland in a stretch from Warsaw to border with Germany. Running trains on commercial bases regularly it would be completely unacceptable for the clients if the trains would be late for such a long time because it would eventually mean failure to make final delivery to the end customer.

Railway station	Date	Arrival	Departure
Kaldenkirchen Terminal	2021-05-29		
Kaldenkirchen Gl. 11	2021-05-29		17:59
Lehrte	2021-05-29	23:38	23:39
Frankfurt (Oderbrücke)	2021-05-30	11:18	13:50
Poznan	2021-05-30	17:16	20:25
Warszawa Praga	2021-05-31	03:27	03:40
Trakiszki	2021-05-31	16:48	17:15
Kaunas Terminal	2021-06-01	09:10	

Figure 60: Actual transportation schedule Kaldenkirchen – Kaunas

Figure 61: Semi-trailers being loaded onto the test train in Kaldenkirchen terminal

Other reasons for a generally long travel time were:

- There were 5 train crew changes during the whole transportation in Germany, Poland and Lithuania. In Poland, the drivers work according to rigid working hours and availability. The switch of train crew every time took up to three hours.

- Three locomotive changes necessary according to current arrangement. For a stretch from Germany and Poland until Warsaw a multisystem locomotive had to be used but had to be changed again because after Warsaw the locomotive drivers working in eastern part of Poland do not have instruction for driving specific multisystem locomotive. Also, it was explained by traction service provider that, multisystem locomotives are more expensive to use. Then locomotives had to be changed again to diesel traction locomotive because Bialystok is as far as electrified line continues towards Lithuania.
- Poor infrastructure in eastern part of Poland. There were big speed restrictions due to infrastructure condition on that part of the route. In some section speed of the locomotive had to be reduced to 20 kilometers per hour over several kilometers.

In addition to that, due to the transport of non-codified trailers, an application for the transport of "exceptional consignments" must be applied for in each country (valid for one timetable year), application is not critical, processing time approx. 4 weeks at Deutsche Bahn (DB) Netz in Germany, in Poland and Lithuania within a few days.

Railway station	Date	Arrival	Departure
Kaunas Terminal	2021-06-01		
Kaunas	2021-06-01		17:50
Trakiszki	2021-06-01	20:13	22:30
Warszawa Praga	2021-06-02	11:04	11:25
Poznan	2021-06-02	17:59	18:12
Frankfurt (Oderbrücke)	2021-06-02	23:09	00:07
Lehrte	2021-06-03	04:14	04:14
Kaldenkirchen Gleis 11	2021-06-03	10:56	
Kaldenkirchen Terminal	2021-06-03		

Figure 62: Actual transportation schedule Kaunas – Kaldenkirchen

After train in Kaunas intermodal terminal was reloaded with new semi-trailers traveling back to Germany it departed again on the same as arrival date 2021-06-01 and came back to Kaldenkirchen at 10:56 of 2021-06-03. Journey back took substantially shorter time – approx. 41 hours because this time there were no major closedowns of the lines caused by infrastructure works in Poland. However, there is a big potential for the travel time to be reduced by even more considering current deficiencies mentioned above.

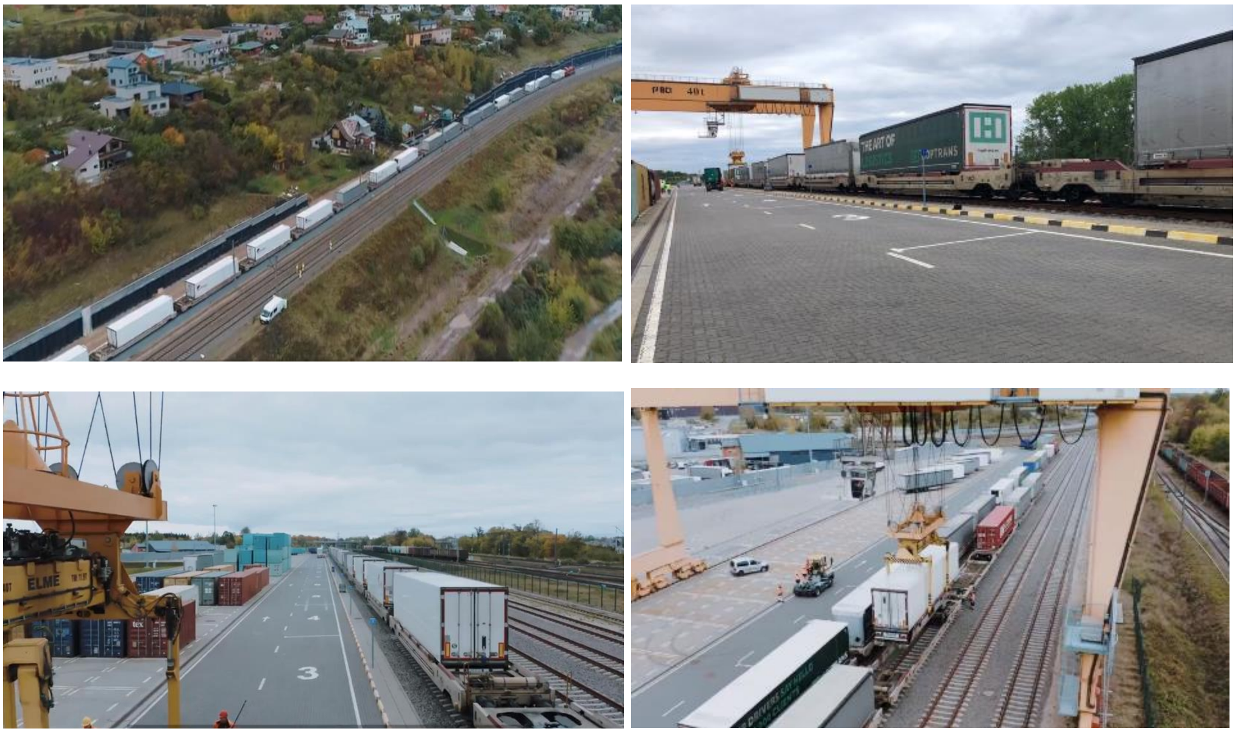


Figure 63: Semi-trailers being loaded onto the test train in Kaunas intermodal terminal

5.2.3.2 Wagons

Since there are almost no craneable semi-trailers now being moved on the corridor it was crucial to be using special technologies for transporting them on rail as traditional T-3000 type wagon does not have possibility to be transporting non-craneable trailers therefore additional equipment has to always be used. Most widely used systems with T-3000 are “VEGA” or “Nikrasa”. Among others independent from T-3000 wagons technologies currently here are two most widely used ones on 1435 mm width gauge network: Lohr and CargoBeamer.

It is not a subject of the study to be analyzing advantages and disadvantages of each of the technology and it will not be done. Both technologies require special terminals to fully utilize their benefits however CargoBeamer wagons can be handled also in conventional intermodal railway terminals such as Kaunas intermodal terminal and many others. The palette in CargoBeamer can either slide out in special CargoBeamer terminal or be lifted in and out using intermodal spreader for handling semi-trailers. This feature of CargoBeamer made it the only choice as there currently is no special terminal of neither CargoBeamer nor Lohr at intersection of two gauges.

Information on CargoBeamer Wagons

<u>CargoBeamer rail wagon - key features:</u>

- Length over buffers: 19,33m
- Weight: 29t including trailer palette
- No electrics, hydraulics, sensors, motors, cabling on the wagon – robustness
- Compatibility to all other freight wagons – can be mixed in trains
- Compatibility to existing crane terminals
- No Jacobs bogies > low axle load < 20 to due to two standard Y27 wheelsets

- fulfillment of UIC 505-1 Profile
- fulfillment of UIC 596-"Huckepack-Profiles" P/C 400, P/C 405 , P/C 410
- Standard brake system
- Authorized for 120 km/h
- Standard coupling gear
- They incorporate a versatile pallet for loading of all standard semi-trailers - which thus become compatible to rail

5.2.3.3 Terminals

For the test transportation Kaunas intermodal terminal was used. It is already connected to 1435 mm width gauge network and has a special spreader to be reloading semi-trailers. There are two 1435 mm width railway gauge track in Kaunas intermodal terminal – 340 meter in length each. Therefore, train after arrival to the terminal had to be spitted in two pieces in nearby marshaling yard. There also are two tracks of 1520 mm width railway gauge but it was not be possible to make reloading of semitrailer onto 1520 mm width railway gauge as there still does not exist wagons for semi-trailer transportation. Semi-trailers from Kaunas intermodal terminal have to continue within Lithuania or towards Latvia, Estonia and Finland by trucks until either "Rail Baltica" link is finished until Muuga terminal or wagons for semi-trailer transportation becomes widely available.

At the other end of the corridor intermodal terminal in Kaldenkirchen (Germany) where currently CargoBeamer has 8 roundtrips per week to Domodossola intermodal terminal (Italy). Since 2015, the terminal reloaded more than 60,000 loads for CargoBeamer, predominantly non-craneable semi-trailers carried on CargoBeamer wagons. The terminal there does not have gantry cranes and all reloading is being done by Reachsteckers.

Figure 64: Intermodal terminal in Kaldenkirchen

Source: https://cabootergroup.com

Once wagons for transportation of semi-trailers becomes available for 1520 mm gauge network as well than it will be possible to transport them further from Lithuania via Estonia all the way to Muuga Ro-Ro terminal belonging to Hamburger Hafen und Logistik AG (HHLA) group (same group as Port of Hamburg) and to eventually reach Finland by sea as explained in chapter No. 2.2. Detailed routing and possible schedule of "Amber train" is available at website: www.ambertrain.eu.

Figure 65: "Amber train" route

Source: https://cargo.litrail.lt/

5.2.4 Lessons learnt, constraints and recommendations

Combined transportation of semi-trailers on the corridor has a huge potential due to a big number of semi-trailers currently traveling by road. However, the transportation simulation model and test run of semi-trailer train has shown that there are many things to be improved so that a regular transportation services could start running on commercial bases.

Firstly, due to a current condition of railway infrastructure and major upgrading works on the line from Warsaw towards German border it takes approximately 5 days to make a full roundtrip including reloading in the terminals. Unfortunately, the current infrastructural condition does not allow to have two roundtrips with one train set even though the distance is just a little bit over 1,5 thousand kilometers which under good infrastructural condition and organizations should definitely allow to do it. Cost of wagon comprise a major part of the total cost of the service. A difference between making one or two roundtrips per week means approximately 150 EUR additional cost per trailer which must be transferred to final customers and might substantially influence the decision of choosing between transport modes not to mention the fact that it makes railway alternative less attractive due to a longer travel time.

Test transportation has clearly indicated major factors negatively influencing the schedule:

- Switching of locomotives three times as a multisystem locomotive must be used between Germany and Poland due to:
  - different voltage systems in the countries.
  - not electrified line from Bialystok to Kaunas.
- Poor infrastructural condition especially on eastern part of Poland which causes a slowdown of the train down to a speed of as low as 20 kilometer per hour in some sections.
- Necessity to change train crew as much as 5 times due to strict driving time regulations in Poland which sometimes means up to additional 3 hours per each switch.

In order to make two roundtrips between Germany and Lithuania it might be two options: either a closer destination in Germany selected or a total travel time reduced down to maximum 36 hours leaving 6 hours for all handling procedures at point of origin and destination without any possible deviations from the schedule. Possible users of the combined transport service has clearly indicated that they are mostly interested in transportation to North Rhine-Westphalia region which is also close to Benelux countries. Closer destinations such as Berlin for example is not of a big interest for them thus leaving with the only viable option to be reducing travel time. To achieved needed reduction of travel time at least one of the following or a preferably a combination of more than one measures should be taken:

Renovation and upgrading of railway infrastructure at eastern part of Poland to make sure that there is no need to be reducing speed due to pure quality.

- Electrification of railway line from Bialystok to Kaunas so there would not be a need to change to diesel traction locomotive or as alternatively to use a multifunctional locomotive that can run through the Poland/Lithuania interchange point. Ideally that should be a diesel-electric locomotive.
- A multisystem locomotive should not be changed in Warsaw and used all the way to Bialystok (until line to Kaunas is not electrified). For this more locomotive driver should be trained driving multisystem locomotives.
- Revision of driving time regulations in Poland to reduce a need to change crew of the locomotive that often.

Secondly, a very important factor is equipment for handling non-craneable semi-trailers as there is almost non-craneable trailers being moved on countries on the corridor. Whatever technology would be used for handling non-craneable semi-trailers it is eventually adding to overall cost of the combined service due to a high investment cost involved. This can only be changed if external support is being provided on national or EU level to support and partially cover investment cost of the equipment to handle non-craneable semi-trailers.

And finally for the combined transport service to be competitive changes in the regulatory environment should be implemented on the corridor such as:

- Increasing road charges to internalize external costs of road transport (air pollution, road mortality, noise and climate change) fully or partially.
- Unified traffic restrictions for heavy vehicles to go over residential areas especially during night and weekends.
- Unified policy of all the governmental bodies at countries on the corridor or EU authorities for covering the difference between infrastructure charges of road and rail. Current regulation is very unevenly set between Germany, Poland, and Baltic states which at this point is still making the service uncompetitive cost wise.

6 RECOMMENDATIONS

Strengthening sustainable transport modes and therewith Combined Transport is one of the main pillars of the EU and member states work programs and strategies. Offering a suitable political and regulatory framework for more eco-friendly transport modes must go hand in hand with industry driven efforts to display best practices and increase the use of those alternatives.

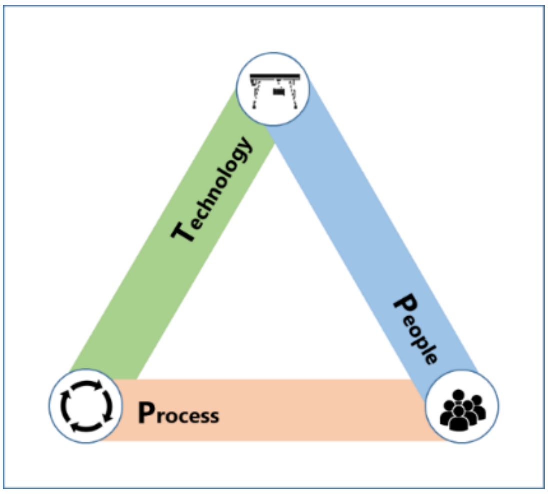


Figure 66: Improvement Dimensions (SGKV, Own illustration)

Actions have to be undertaken in a holistic manner aiming at a joint optimization of people, technology, and organization to ensure a sustainable growth of CT in the coming years in the Baltic Sea Region. With the existing experience of a broad variety of intermodal traffic in Europe industry is developing technology and processes to provide customer oriented transport chains. In order to exploit the potential for CT transport, a series of measures and starting points are presented here. We cluster them into the groups, recommendations for efficient customer oriented organization, optimization of change of transport modes (automation), reaching high utilization of ships and rail on main leg and communication to get new customers for CT. The results are complemented by study results from the project partners LTG Cargo and LLA.

6.1 Efficient customer-orientated organization

Improve transport organisation aiming at a higher utilization of CT by customers to meet greenhouse gas emission requirements is a crucial task. With regard to realize more customer friendly processes a simplification of current regulation and process organisation is required together with the urgent need to motivate customers to use eco-friendly transport alternatives.

One of the major tasks is therefore to offer transparent communication in order to demonstrate ease of CT transport organisation for the customer and to improve reliability in the transport sector, transparency and comprehensibility can be seen as the main buzzwords to achieve this.

- **Use of communication and transport organisation platforms for CT**

Numerous platforms are in operation or being recently created to simplify communication issues between stakeholders of intermodal transport chains. The most promising of them is maybe the project KV 4.0, funded by BMVI in Germany, aiming to digitalize intermodal transport chain operation/communication. The overall objective of the project is to make the logistics process more transparent and clearer across the entire intermodal transport chain and across national borders. With the help of a new common data hub to be developed and via standardised interfaces, all participants will have direct access to transport-relevant parameters of combined transport (e.g. order and timetable data, arrival forecasts and transport-related information) (Hupac Intermodal SA, 2020c).

Furthermore specified platforms are operated by stakeholder consortiums or even open accessible to improve transport chain operations and communication between shippers, forwarders, train operators, terminals and more. Some of them are e.g., CATKIN (Catkin GmbH, 2020), IMSLOT (4PL Intermodal GmbH, 2018), csCONNECT (Cargo support GmbH & Co. KG, 2020), xChange (XChange Solutions GmbH, 2020), Modility (modility GmbH, 2020).

- **ETA (estimated time of arrival)**

Efficient planning of transport chains is related to knowledge on transport processes and therefore the movement of the intermodal loading units to organise next steps in the chain. Making an estimate for the arrival time of an international freight train is a real challenge due to the centrally-planned allocation of infrastructure capacity. Many actors in the sector have already embarked

on efforts and projects to the resolve the issue. This has resulted in many dedicated or company-specific software solutions, e.g. Train Radar (Hupac Intermodal SA, 2020a), SYNFIOO (Synfioo GmbH, 2020), SMECS (Jonas Brands, 2020).

- **Enhancing comprehensibility and understanding of CT chains**

Skilled workers are crucial in every branch to ensure efficient and target-oriented operation. Detailed knowledge is also required in procurement and awarding of contracts with regard to consider CT as an option to choose. Against this background education and communication measures are necessary to ensure basic understanding on positions responsible to organise or start transport processes. To improve understanding of CT system, as a precondition to increase use by customers, associations and industry are promoting basic knowledge and communication platforms, either dedicated to specific tasks or more general for CT, e.g. Intermodal Info (SGKV, 2020a), ENECE (United Nations Economic Commission for Europe, 2020), UIC (International union of railways, 2020), network information (e.g. Hupac Intermodal SA, 2020b), terminal information (e.g. SGKV, 2020b, RailNetEurope, 2020)

- **electronic freight documents**

Even in times of digitalization and highly connected processes many shipping documents are still paper-based and handed over manually. This is still done although it has many disadvantages compared to using the digital way. For instance, it takes much more time to share information and to trigger processes, which are based on the information contained in these documents. Furthermore, this kind of documentation is far away from transparency and there is always the risk of losing information, what can slow down the process and increase the time for clarification. Because of this, it is urgent time to set the framework conditions for the electronic waybill as a standard solution to make use of the technical possibilities. It is common understanding that sector and authorities have to establish a system enabling the transfer of electronic freight documents to adapt freight transport communication to actual requirements.

The EFTI approach of EU is based on regulation (EU) 2020/1056 on electronic freight transport information (hereinafter the eFTI Regulation) which establishes a harmonised framework for the electronic communication of regulatory information between the economic operators and authorities in relation to the transport of goods within the European Union. In particular, it establishes the obligation for the authorities to accept this information electronically, under the condition that the operators make this information available to the authorities by means of secure and certified information and communication technology (ICT) platforms (the eFTI platforms)[1].

6.1.1 Main findings of a feasibility study commissioned by LTG CARGO

Nowadays, the client's choice not only depends on quality of service, but also on the same client nature - its size, geographical location, shipping volume, flow properties and intensity. This shows that in addition to efforts to provide efficient transportation and competitive services, service provider's success depends on how differentiated it is able to work with clients.

Customers expect to receive the full door-to-door/port-to-port/terminal-to-terminal service package. So, service providers must be able to offer each of the supply chain's component, even if not every customer need that. In addition service provider is obliged to provide customs procedures and starting / ending road transportation (to / from the domestic terminal) and empty container/semi-trailer pick-up or delivery services. Also service provider has to operate or have access to the empty container/semi-trailer depot in the inner terminals or close to them.

Study IQ - Intermodal Quality (2000) systematized the factors that motivate the cargo owner to choose between railway (road / rail) and road transport. As can be seen from the chart, this study revealed the 10 most important factors affecting the cargo owner's decision:

- Transit time	- Tracking
- Reliability	- Security
- Flexibility	- Price
- Staff competence	- Logistical infrastructure
- Contractor availability	- Support services

Table 14: factors affecting the cargo owners decision

In 2015, the EC has commissioned a study of a similar nature – "Goods by road: why the EU shippers prefer the truck before the train." Study identified 7 factors that determine the shipper decision:

[1] Information note on the state of play and future implementation of Regulation (EU) 2020/1256 on electronic freight transport information29 to the Correspondents of Regulation (EC) 1013/2006 on Shipments of Waste, 25.09.2020

- Price
- Time
- Reliability
- Security
- Flexibility
- Frequency
- Intermodality

Table 15: factors that determine the shipper decision

Customer satisfaction topic was discussed on BE LOGIC Project, financed by the EU FP7 research program. Project includes design of benchmarking methodology of intermodality quality. The following figure shows the criteria based on which it CT service quality is described. As can be seen, the success of combined transport services, for different customers, depending on their operational needs and shipping characteristics, led by 17 factors, but four of them - information management, submission wagons, reliability and punctuality were among the most important.

Figure 67: Survey results on efficient customer-orientation CT-organization (BELOGIC Project)

Similar levels of service (reliability, speed, flexibility, punctuality) are expected from global logistics as, for example, from domestic logistics. On the other hand, the suppliers of logistics services are more often global enterprises or networks of companies.

International logistics companies can operate cost-efficiently through a developed hub-system and a network of subcontractors. A hub-system in freight transport is described as a central freight terminal, which has frequent connections from other terminals within the system. A hub-system concentrates transport flows to certain, often scheduled routes which smaller transport flows are linked to, thereby benefiting from economies of scale. As a result of the hub system, freight flows do not use the most direct route, but they will be optimized according to the cost and schedules of the hub-system of every logistics network. New significant terminals or the combining of old terminals can significantly change the route choice of international freight transport.

The increasing use of containers and semi-trailers in transport has increased the share of intermodal transport chains, which contain several modes of transport. Cost-efficient railway or sea transport is used on the main routes of intermodal transport, while flexible road transport is used in collection and distribution activities. The EU transport policy favors intermodal transport instead of direct road transport for environmental reasons. The functionality and efficiency of intermodal transport chains are developed in many ways for promoting transport. Global transport chains, which are often intermodal by nature, will also benefit from this.

The most valuable goods are transported in containers and semi-trailers, and efficient transport demands developed infrastructure and level of service. The share of container goods in international transport has significantly increased and this growth is estimated to continue.

Other possible success factors in order to organize efficient transport:

- Differentiated approach to individual goods and their respective operating characteristics	- Regional distribution platforms
- Own forwarding and transportation of plaster optimal utilization	- Part of global network
- Broad geographical areas of cargo consolidation at both ends of the route	- Know-how – experience on an international market and investments
- Innovative company management and staff approach to service development	- Reliability and quality
- Very strong network for transportation by road and rail	- Customers orientation
- Strong customer base diversification	- Efficient linkage of transport modes
- Advanced technology and supply chain management schemes deployment	- Corridor concept
- Traction + Operator from a single source	- Innovative company management and staff thinking
- Value-added-services / Integrated IT	- A wide network of intermodal terminals
- Highly productive terminals	- Wide combined transport network of partners
- License and traction from a single source	- Aim to reduce the negative impact of transport to the environment
- Experienced personnel	-
- Optimized equipment utilization	-

Table 16: success factors in order to organize efficient transport

There are obstacles for efficient transport organization, which can be identified into four main groups:

- technical (unavailability of service, long transit time and lack of punctuality, lack of capacity and unequal opportunities, different traffic management systems);
- economic (price);

- legal (lack of equal regulation);
- political (lack of rail transport promotion).

6.1.2 Survey results on requirements for realizing intermodal transport chains in Latvian Hinterland Traffic (LLA)

Summary of conversations (including by phone) with wholesalers and retailers, logistics providers as to what it would take to send cargo / semitrailers to/from ports and between inland terminals by rail instead of road.

Appropriate infrastructure

Most of logistics and distribution centers in Latvia currently do not have rail access. It would require huge investments or even be impossible to build them. As a result it would take additional time and expenses if a company chose to use both rail and road transport now. Another problem would be management/movement of empty semitrailers and/or containers, etc. A solution would be if the rail service provider owns them.

Price

If rail transport is not cheaper or at least on the same level than road transport companies will not have the motivation to change their well-established routines.

Time

Time of a service is of the essence, it could be a little bit longer if the price is attractive. Routes inside Baltics, e. g., Riga – Tallinn or Riga – Vilnius is only about 300 km, however, currently it will take more time to deliver goods door to door by rail + road than only by road transport.

Flexibility and guaranties

On the one hand, as daily cargo flow of a company may substantially differ flexibility of the rail service is very important as far as capacity is concerned. On the other hand, guarantee of the service availability

6.2 Optimisation of change of transport modes (automation)

New technologies may serve as tools for the optimisation of terminal processes and make them even more productive. Most of newer technologies in termials focus on utilities to speed up processes (automated data exchange) and/or simplify procedures (using AR /VR for checks, track and trace) by using approved technologies.

An increasing digitalization and technical innovations open up new possibilities in the terminal operation environment. This means that new high-tech solutions can make the work easier for employees and enhance the quality level even further.

To make terminal operation more efficient and increase capacity numerous measures were tested and implemented the last years, some of the most promising are mentioned following. It must be taken into consideration that measures are not to be implemented in every terminal surroundings, frame conditions as space and regulatory requirements are differing on individual location.

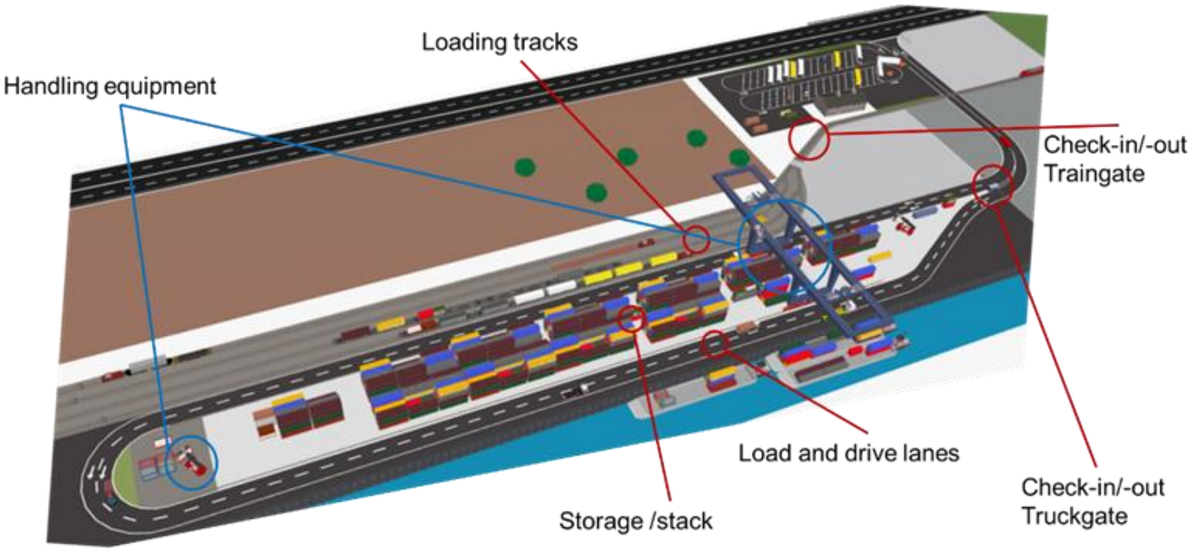


Figure 68: Terminal Structure (SGKV, Own illustration)

- **(part) automation of handling equipment (handling equipment / storage Area)**

Gantry crane operation can be (partially) automated to ensure efficient operation and support crane operators as well as terminal operation planning. In European Hinterland terminals a fully automated operation of crane handling can only be seen at the BASF facility in Ludwigshafen on their own dedicated yard. Automation requires the non-access for people to the operated area, which is for most terminals not applicable. While this requirement is hardly to achieve a part automation will increase the next years, e.g. KÜNZ will deliver several remote operation setups in 2021 that will be linked to a part automation of the crane handling, which means the crane operator will operate from a remote desk mainly the lock and unlocking process while driving is done automatically.

With regard to storage areas or repositioning/bypassing operation of AGV (automated guided vehicles) is seen as equipment that will be widely spread in future operation. Current operation is already visible at seaports (Hamburg Altenwerder) or in Hinterland terminals (DUSS Lehrte) and again BASF Ludwigshafen (BASF SE, 2020).

Together with automation approaches predictive maintenance measures are considered as main actions to increase availability and efficiency of existing equipment. Predictive maintenance aims to detect prior to brake downs possible failures and enable suitable maintenance measures in less crowded time slots to avoid capacity breaks.

Furthermore, a more elaborated control of crane operation with regard to optimised routing and stack organisation is considered in automation approaches linked to the TOS (terminal operation system) implementation.

- **OCR gates (optical character recognition at Truck/Train Check in/out)**

The use of advanced OCR gates offers, together with interfaces to a performant TOS, the possibility to increase organisation speed of handling operation and loading unit movement control within the terminal and in communication with steps in the transport chain ahead or before.
Information capture by OCR supports the identification of the loading unit and the check of the conformity /safety for rail/waterway transport against references. Taken pictures can be analysed to match data with existing freight documents in the TOS and start handling routines as well as to identify needs to further check damages or safety risks caused by deformed loading units.

- **Slot Management (Check In / out gate Truckgate and Terminal organisation)**

The time planning of arriving trucks at the terminals is for some terminals a huge problem. Currently, there is no organized slot management that regulates the arrival times of the trucks at the loading location. As a result, at certain times a particularly large number of trucks are arriving at the loading locations and have to wait several hours until the goods are transhipped on the wagons. One reason for that problem is that the upstream producing suppliers just focus on the efficiency of their own business environments and thus optimize their processes at the expense of the logistics. This problem is a sign for a lack of holistic thinking and collaboration with up- and downstream parties in the supply chain. By assigning fixed arrival times for each truck at the loading point created by the terminal (incl. a certain flexibility), handling of the goods could be regulated by time. If all suppliers adhere to their allocated slots, the occurrence of peak times can be avoided and the transhipment volume can be distributed throughout the timeframe. In addition, there are no traffic jams, waiting times or idle times. If a truck misses its scheduled time slot, it must wait until the end or until another time slot becomes available. In order to motivate the production facilities to stick to the time slots, the occurring costs at the terminal side could differ according to the arrival times for the supplier. Furthermore, the connected parties within the supply chain need to collaborate to find advantages for both sides by improving the whole chain instead of improving individual business environments.

- **Wagon inspection (Train outgate)**

The Wagon Inspection could also be supported by photogates or laser scanners. A freight train passes through a gate where several cameras or laser scanners are mounted. It is completely scanned and the actual state is recorded as a (3D) image. In comparison with the target state, detached connections or similar states can be detected. An advantage is that considerable time saving can be achieved, since the train runs during the inspection and the train can be checked from all sides at the same time. In addition, the technology can be used outdoors with suitable protection and for bigger dimensions. The technician would just need to check manually in case that the systems detect deviations from the target conditions of the checked parts. The cameras or scanners will be placed for trucks at the gate-in and for rail before the CT-Terminal. The loading units will be checked automatically and only in case of damage or other irregularities, the technician will be informed. Like augmented reality solution that can be also applied to support check processes, it helps with the prevention of human errors and reduces idle time even more.

6.3 High utilization of ships and rail on main leg and exploiting benefits of implementing new technologies on the main leg

The implementation of new technologies on the main leg (waterway, rail) of a combined transport improves speed, capacity or (economic) efficiency of the transport process. The global system of CT is growing since 50 years based on robust and proven technologies, new technologies entering the market are mainly either supporting existing processes by digitalisation and automation or leading to a product diversification, e.g. the efficient transport of non craneable semitrailers by rail.

Implementing such technologies may lead to significant improvement of the CT system, the implementation process however is time consuming so that for COMBINE a qualitative assessment only is reasonably practicable.

- For the **rail sector** the possible introduction of horizontal loading technologies as Cargobeamer (SGKV, 2020d), Lohr (ibid. 2020d), Helrom (ibid. 2020d) etc. may lead to increased utilization of existing railway lines and time slots due to a theoretical faster handling of trains in terminals.
- The europeanwide implementation of ETCS (European Train Control System), a computer-based system to support the train driver, aims of reducing the large number of different train control systems in Europe and implement an uniform and interoperable European standard. This harmonization of systems and processes is intended to create an increasingly continuous cross-border traffic by reducing the technical barriers and the reliability of cross-border rail operations increase. The introduction of ETCS is based on EU directives and specifications, the EU has defined the requirements for the use of ETCS on the trans-European rail network in the Interoperability Directive "2016/797". The directive sets out the conditions that must be met for interoperability of the railroad system in the European Union must be fulfilled. The aim of the directive is technical harmonization and the improvement and Development of rail transport services within the EU and with third countries. Thus, the establishment of a single European railroad area is to be achieved. (DVV Media Group GmbH, 2020)
- For the waterway sector new technologies are mainly dedicated to increase fuel efficiency of ships or introducing alternative fuels. With regard to CT transport chains a focus on port handling operation could reveal benefits on start and end point of the waterway main leg. Loading and unloading of vessels may be in future be supported by using AGVs. With regard to current semitrailer handling the implementation of such supporting technologies will create efficiency benefits by optimising operation processes and speeding up handling processes to enable punctual and theoretically more frequently departures. AGV operation is at deployment in seaports (Hamburg Altenwerder), tested in main Hinterland terminals (Ludwigshafen BASF) and also in development for more facilities (e.g., VERA, Volvo).

6.4 Efficient last mile transport

In the following chapter, we present the key findings on Efficient last mile transport that were developed in work package 4.1 of the COMBINE project by the University of Gdansk. Therefore, Efficient last mile transport is subdivided into three subareas (6.4.1) increasing capacity, (6.4.2) alternative propulsion and supporting tools, and (6.4.3) providing the latest innovations which can have real influence on last mile operations.

6.4.1 Increasing capacity

Key Findings

- LHV are the easiest way to improve the capacity of CT last mile operations in BSR.
- Currently LHV are legally launched in Northern and Western BSR, South and Eastern countries allow vehicles according to EU directive standards.
- There are multiple combinations to build LHV, most of the equipment is widely available in BSR both new and used market.
- Extending LHV network requires mainly legal works, new built infrastructure is ready for LHV, although additional studies for particular road sections might be required.
- Launching LHV on last mile deliveries allow to receive even 30% decrease of transport costs per unit, GHG emissions can be reduced by 11% respectively.
- Platooning is the latest technology which aims to increase capacity of CT operations.
- Latest tests prove the readiness of technology to be launched in market conditions, although, legal works are still underway, a lot of infrastructure works in Europe and BSR will be also required.
- Real suitability for BSR market is hard to estimate, due to necessity of checking real cargo flows from/to terminals in particular period of time
- Autonomous trucks technology seems to be ready to launch in a short period of time, despite lack of law preparation.
- First terminals which should be considered for such traffics should be localized in the nearest area of distribution centers to allow autonomous trucks work on internal pathways instead of public roads.
- Management of autonomous trucks may affect to rise new, innovative market players – autonomous vehicles management and maintenance companies.

6.4.2 Alternative propulsion and supporting tools

Key Findings

- Shape of propulsions in last mile operations will be created mainly by EU policy within the scope of reduction CO_2 emission.

- NG vehicles are the most common available alternative propulsion trucks in BSR, but the emission levels are still under research process.
- Future of NG trucks depends on the possibility of using biogas or LBG/CBG which are considered as renewable sources of energy, and comprehensive network of fueling stations.
- Return on investment in LNG trucks is feasible only in transportation on long distances relatively heavy loads, thus for CT last mile operations LNG trucks might be not economic efficient.
- Increased weight of electric trucks – mainly due to batteries installed on board should push to rise the limitations on max permissible weight of truck/trailer combination.
- Range of electric trucks suitable for CT operations is limited, most of them are custom builds which increase the costs of purchasing and limits the development.
- New registrations of pure electric trucks rise in BSR by 115% y/y, mainly in Germany, thus development of fast charging stations and its' rising number in BSR is a must.
- E-Highway should be considered as transitional solution and due to significant costs, should be implemented only on heavy traffic nodes and CT terminals. Although, retrofitting diesel trucks into trolley-trucks seems to be interesting way to extend the lifecycle of the older truck fleet in BSR.
- Hydrogen fuel cells is the latest technology which is under first tests in distribution trucks in Europe, next step which can be considered is to implement it to CT operations.

6.4.3 Providing the latest innovations which can have real influence on last mile operations

Key findings

- Efficiency of last mile operations in CT depends not only on the mean of transport but also on external factors, like using special ILUs or additional terminal or warehouse equipment.
- Stakeholders in last mile operations should consider IT solutions as a tool to improve the company effectiveness by measuring the performance and by avoiding empty runs of trucks.
- Launching LHV vehicles will require continuous verification of ILU mass to avoid truck overweight. It might be possible due to good market availability of mass checking devices.

6.5 Focus on communication to get new customers for CT, creating new transport chains

Communication can be mentioned as another success factor for increasing utilization of CT. The exchange and transfer of knowledge between employees in a permanent performance dialogue serves the goal of a higher utilization of CT in transport chains. Customers / shippers must be motivated to use this eco-friendly transport alternative, transparent communication is therefore a crucial requirement. The EU is supporting such efforts by promoting alternative modes of transport with highlighting e.g. the year of rail 2021.

From another project, with involvement of SGKV, basic and frequently asked questions how to get into CT were taken and used to create a basic guideline to get into discussion with potential customers.

Following these basic questions guideline on use of CT is represented, referenced it is to the ERFA project of Fraunhofer IML and SGKV (SGKV, 2020c).

Operational Organization	
General organization and procurement of information	
How do I find contact persons?	· Experienced or newly founded carriers with knowledge on CT (who can organize all aspects of the shipment, in case of acquired CT expertise). · Terminal operators (give information on possible connections, carriers and operators) – e.g. refer to intermodal-map.com, railfacilitiesportal.cu · Operators (offer rail transport and handling); see chapter 4.2 for a list. · Contact established shipping companies for marine transport (some also offer to organize the linked seaport hinterland transport). · Refer to online booking platforms (e.g. box2rail), digital shipping agencies (e.g. FreightHub) or collaborative communication platforms (e.g. NexTrust).
What kind of loading unit do I need for the shipment?	· Containers, (cranable) trailers or swap bodies → Some terminals only handle containers → Some shippers have dimension limits for loading units due to heights of tunnels and bridges → LUs can be bought, rented, leased or already be included in the carrier's quote → Advantage: total gross weight of 44 tons permitted in the initial as well as final leg.
Do I need to make changes to my own processes?	→ Note: create awareness — CT depends on A-B-connections (terminal A – terminal B), as well as on the organization of the initial and final leg. · Yes, in case my processing times are not compatible with the carrier's timetable. → Check internally time frames and punctuality rates · Yes, in case my current carrier does not offer CT solutions. → E.g. new procurement, parallel placing of orders with road and rail forwarding agents, training for dispatcher · Yes, in case the operator only offers circular tours. → It is the carrier's responsibility to review the capacity utilization (carriage without load or fully loaded)
What is the minimum order quantity?	· 1 LU for the first order (container, swap bodies, trailer) · Larger discounts for continuous shipments · From the operator's point of view, 80 % train utilisation is usually necessary. · Fixed quantities in case of company trains (the capacity utilization risk bears the carrier).

Table 17: Operational Organization

General Conditions	
For CT suitable types of goods, time of transport and transport distances.	
Are my goods suitable for CT loading units?	· Yes, nearly always if your goods can be packed into a container, swap body or a trailer and can be transported in it securely. · It is also possible to apply special equipment in CT according to cargo characteristics (general cargo/ bulk material and its volume, weight, temperature and ventilation requirements).
What are currently reasonable transport distances for CT?	· A transport distance of 300 km or more makes it reasonable to consider CT and to get quotes. (only 1 % of the total CT transports are shorter than 300 km). When transporting goods to seaports, however, CT is already worth considering from 200 km on. · Distance to nearest suitable terminal: 30 km (10 % of successful CT shippers also have longer distances to terminals; distances of up to 100 km are still reasonable in case of very long total transport distances).[10] · In cases of a total transport distance of at least 300 km with an initial leg of 30 km, CT runs cost-neutrally compared to truck transport. For shipments with a total distance of 500 to 700 km CT is often significantly cheaper.
How can I find my starting point and destination?	· Search online for terminals nearby (about 30 – 75 km radius) e.g.: intermodal-map.com, railfacilitiesportal.eu (see chapter 4.1), which also give their according contact details. · Research on operators' websites concerning up-to-date timetables. · Compare them with your own schedules.
What shipping times can I expect?	· Departures according to regular shippers' timetables (1-6 times a week at the same time: departure is traditionally in the evening, arrival in the morning). · Punctuality in CT is at times less reliable compared to road freight traffic. · Possibility of interim storage in terminals (buffering), if needed. · Partial transport organization via two modes of transport can be useful (switch to trucks on short notice, however, main transport distance via rail).

Table 18: General Conditions

Factors of Sucess	
Aspects of a successful entry into CT	
Transport quantity and frequency	· The more goods are transported, the better. · The typical market's minimum requirement is 3 circular tours per week (often only circular tours are offered).
Heavy goods	· CT's big advantage is in the transport of heavy goods due to its increased 44-ton weight restriction in the initial and/or final leg.
Transport distance	· With a growing transport distance of at least 300 km, CT is increasingly cost effective and therefore more attractive.
Night / bank holiday driving bans	· Transports which suffer from bans on driving at night and on bank holidays, as well as restrictions on truck traffic, for example in Austria or Switzerland, can avoid them by using CT.
Willingness to engage with CT as a topic	· Obtain information and compare: → Training of dispatchers → Information websites see chapter 4.1 → Combined operators see chapter 4.2
Social responsibility as an important business factor	· Using CT reduces CO_2 emissions as well as the traffic load on roads significantly. · These external factors work in favor of CT. However, they are only important to companies, which considering social responsibility as a priority themselves or their customers do so.
Appropriate connection nearby	· The crucial aspect, which often leads to the failure of inquiries, is still the availability of suitable train connections.

Table 19: Factors of Success

6.6 Focus on highlighting the sustainability benefits of combined transport

The final recommendation for implementing international CT chains in the Baltic Sea Region is to attract more users to this mode of freight transport. A key advantage of combined transport is sustainability quotient not only due to its use of eco-friendly modes of transport for the major parts but also the possibility to ensure sustainable practices within its operations. Hence, the need to focus on highlighting the sustainability benefits of combined transport is recommended together with a tool kit for a quick self-review, planning, and promotion of combined transport in BSR. The development, testing, and future potentials of the tool kit are explained in the following sections.

6.6.1 Motivation

One of the key benefits of Combined Transport is its inherent characteristic of sustainable freight transport. To improve the awareness of this benefit to the CT stakeholders and to make it transparent to the entire market in the Baltic Sea Region, SGKV developed and tested a sustainability review toolkit. This tool kit is designed to transfer knowledge on sustainability to the CT market and enable the users to perform a simple test evaluation of their sustainability practices. Reporting sustainability initiatives of the CT players can help promote CT as the freight transport solution for the future. It also helps the companies to make strategic planning in line with the United Nations sustainability goals. The tool was planned based on KPI evaluation technique. Such performance management systems ensures that companies and processes are going in the right direction, achieving targets in terms of organization's sustainability goals and objectives transparently.

6.6.2 Approach

The approach to the development of the tool kit was pivoted around the transfer of knowledge on sustainability to the users. Therefore, a structured approach from the definition of sustainability, its three main pillars of ecology, economy, and social were focused on as the basic information. Thereafter, building upon this platform, the globally recognised Sustainability Development Goals (SDGs) of the United Nations were to be introduced. The structure of the United Nations SDGs was as represented in Figure 72 with each goal consisting of several targets and key performance indicators.

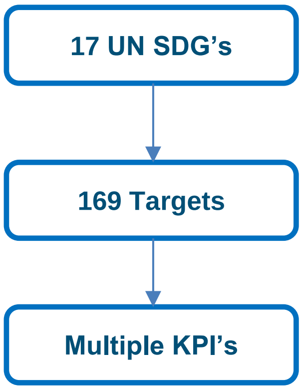


Figure 69: Structure of United Nations SDG's

With the goal of developing a tool kit for the Combined Transport sector and the Baltic Sea Region, SGKV studied the different goals, targets, and key performance indicators to identify the most relevant ones for the CT chains. For example, in Goal number 9 - Industry, Innovation, and Infrastructure, the overall goal is to build resilient infrastructure, promote inclusive, sustainable industrialisation, and foster innovation. Within the scope of this goal, there are five targets with specific areas of interests. From a CT perspective, the target four that addresses improved resource usage efficiency, adoption of environmentally sound technologies is a key target with possible KPIs like amount of greenhouse gas emissions, carbon dioxide emissions, expenditure towards environmental protection, among others. In a similar approach, SGKV has collected the most relevant SDGs, and KPIs, for the Combined Transport sector in the Baltic Sea Region. Based on the expertise of SGKV and its members, the structure of SDGs presented in Table 20 below was chosen as the basic construct of the tool kit.

COMBINE	Sustainability Review Tool Kit — SGKV
UN Sustainability Development Goals	**10 UN SDGs for CT**
Description	**Description**
NO POVERTY	NOT APPLICABLE
ZERO HUNGER	
GOOD HEALTH AND WELL-BEING	GOOD HEALTH AND WELL-BEING
QUALITY EDUCATION	QUALITY EDUCATION
GENDER EQUALITY	GENDER EQUALITY
AFFORDABLE AND CLEAN ENERGY	AFFORDABLE AND CLEAN ENERGY
DECENT WORK AND ECONOMIC GROWTH	DECENT WORK AND ECONOMIC GROWTH
INDUSTRY, INNOVATION AND INFRASTRUCTURE	INDUSTRY, INNOVATION AND INFRASTRUCTURE
REDUCED INEQUALITIES	REDUCED INEQUALITIES
RESPONSIBLE CONSUMPTION AND PRODUCTION	RESPONSIBLE CONSUMPTION AND PRODUCTION
LIFE BELOW WATER	
CLEAN WATER AND SANITATION	CLIMATE ACTION
SUSTAINABLE CITIES AND COMMUNITIES	
CLIMATE ACTION	
LIFE ON LAND	
PEACE, JUSTICE AND STRONG INSTITUTIONS	STRONG INSTITUTIONS
PARTNERSHIPS FOR THE GOALS	NOT APPLICABLE

Table 20: Construct of Sustainability Review Tool Kit

The SDGs were then assigned to the three pillars of sustainability as shown in Figure 73. The SDGs and the KPIs focus on evaluation of the current performances. However, to enable effective planning based on the tool kit, a set of best practices from the industry globally was chosen to be included as an existing example of possibility to improve to the users. This empowers the users not only to analyse their operations, but also make strategic planning based on best practice examples.

Figure 70: CT SDG's and Sustainability Pillars

In pursuit of identifying the most suitable KPIs and best practices, over 30 studies about sustainability in CT, terminals, harbours and as well as existing sustainability reports were analysed and matched with one of the three pillars. These references are listed in the Literature section of this report and are also made available to the users of the tool from the tool interface and the accompanying report. Including the methodologies followed by the container ports, the approach to the tool kit was designed to permit the users define their own goals and evaluate their performance against self-defined targets. Such an approach provides flexibility to the users depending on individual operating environments and allows them to self-evaluate, plan, or market their sustainability practices effectively with the primary goal of knowledge transfer to all stakeholders in the market.

6.6.3 Sustainability Practices Review Tool

The first step following the approach discussed in the previous section is getting an overview about sustainability, the three pillars of ecology, economy, social, and its importance to the combined transport sector. It is followed by the specification of the United Nations sustainability development goals along with an example of KPIs and Best Practices. Then the users are requested to record their contact information for sharing the report and select the goals that are the most relevant to them. For all the chosen sustainability development goals, a short description is shown apart from sample KPIs and Best Practices, respectively. The actual evaluation follows in the next step, before concluding with a dashboard output that shows the sustainability performance of the user in general as well as differentiated to social, economic, and ecological performance as represented in the Figure 74 below.

Figure 71: Sustainability Practices Review Tool – Work Flow

The tool kit provides the user a friendly introduction into the overview and flow of the tool at the beginning as seen in Figure 75 (L) below. Since the aim of the tool is not only to evaluate the level of sustainability of the users but also about transferring knowledge, the user gets a concise knowledge input in the following window as in Figure 75 (R).

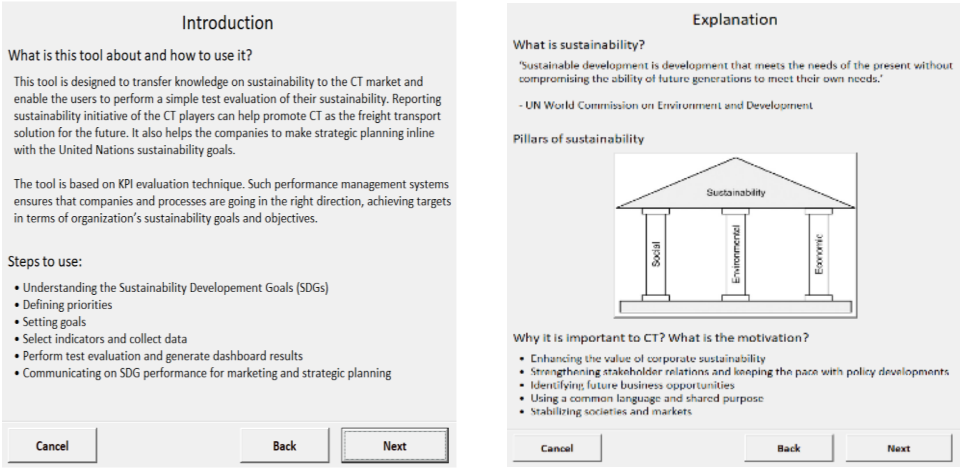


Figure 72: L) Introduction to Tool, R) Knowledge Input

Knowledge about sustainability in general, the global UN sustainability goals, the integration of the three pillars ecology, economy and social in its entirety as a base of sustainability and why it is important to the CT market are introduced in the next step as in Figure 76. Subsequent the 16 SDG's without the partnership for the goals are listed and there is the first possibility of getting into the first example of key performance indicators (KPI's) chosen for the CT market and as well for the corresponding Best Practices, which are solutions to reach the chosen targets already implemented by different terminals.

Figure 73: United Nations SDGs in Tool Kit

As a next step the user is about to start the evaluation. Before getting into the KPI evaluation there is a request for contact information and selection pane to choose which of the 10 SDGs suited to combined transport market, the company wants to evaluate themselves depending on own prioritization as captured in the Figure 77 (L). But before actually starting with the evaluation, all chosen SDGs are listed and described again. Furthermore, there is the possibility of getting an example KPI and Best Practice for every chosen SDG as seen in Figure 77 (R).

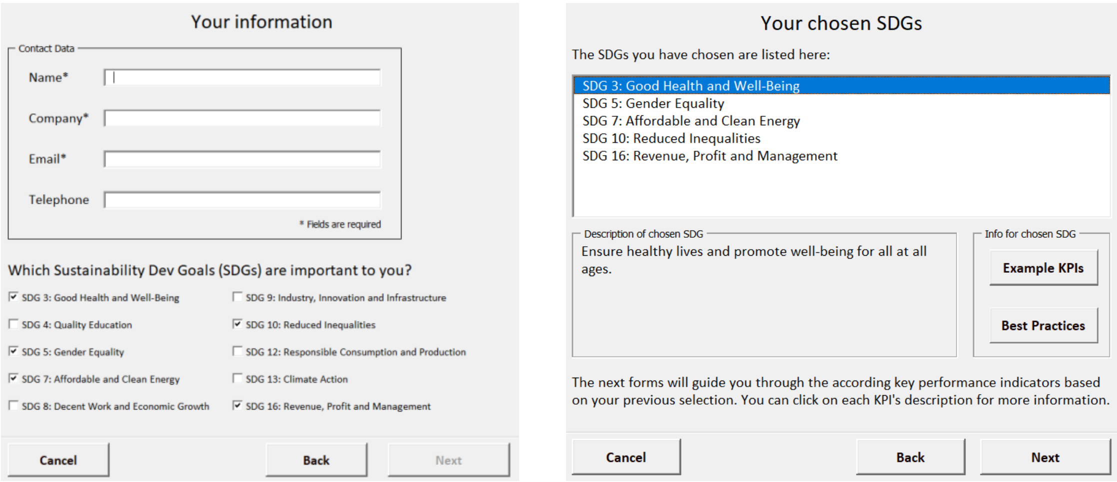


Figure 74: L) Contact information and SDG selection, R) SDG descriptions and examples

The following windows are the main parts of the KPI based evaluation. Therein the users can set their own goals for the KPI's and fill in the corresponding current values. The tool is organized to be very flexible in terms of leaving out information as well as going back to the overview to readjust the previous selection without losing entered data. Depending on the performance of the user the "SDG Score" is switching between red, yellow, and green to give the user already a quick feedback as seen in Figure 78 (L). In case of the necessity of further description of the KPI, there is the possibility to directly click on it and access a more detailed description of the KPI for better understanding as shown in Figure 78 (R).

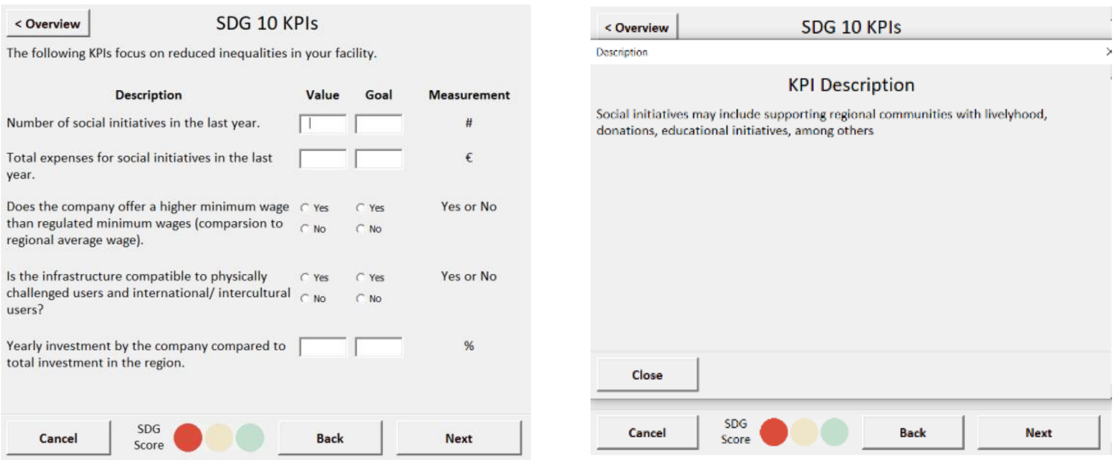


Figure 75: L) KPI Evaluation, R) KPI Description

Once the user finishes the input of the data for the chosen SDGs a dashboard shows the evaluation of their performance. At first bar charts for every single KPI to compare the filled in values with the user's goals are presented as in Figure 79 (L) and automatically downloaded as images for further use. In the second step of the dashboard, the user gets a scoring for different categories of sustainability development goals. At the top of the window, the “SDG Performance” that was already individually visible while filling in the values is now shown clearly for all chosen SDGs. To not only evaluate the performance for the different SDGs there is also a “Sustainability Pillars Performance” which gives an evaluation for the three different pillars namely, economy, social and ecology on a tachometric scale from “Bad” to “Super”. At the bottom of the window, as the last output of the tool the user gets an overall sustainability score ranking as recorded in Figure 79 (R).

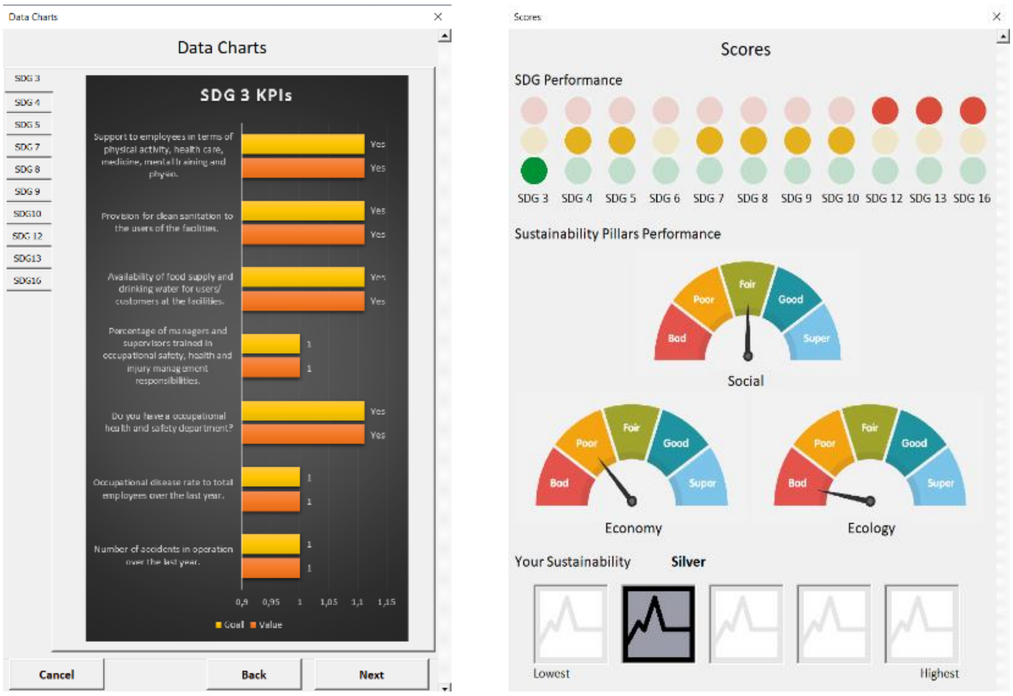


Figure 76: L) KPI Evaluation Dashboard, R) Sustainability Performance and Scores

6.6.4 Testing and Feedback

The development of the tool kit was performed in continuous consultations with the members and the related expertise at SGKV. Being a neutral organisation between industry, science, and policy making, it was feasible to consult different members of the CT sector on the structure and contents of the tool kit. This served as an internal test and development iterative cycle. Furthermore, to gain an external perspective to the tool kit, SGKV introduced the tool kit to the member of its advisory board and sought their feedback. The advisory board included representative of the German Federal Ministry of Transport and Digital Infrastructure from the Department G14, and operator of multiple combined transport terminals namely Deutsche Umschlaggesellschaft Schiene–Straße (DUSS) mbH. Such a two-pronged approach covering internal and external stakeholders supported in the development of an industry oriented and robust tool kit.

As an example, meetings were held with CT terminals wherein the usability of the tool was questioned as well as if the SDG structure were suitable and if the chosen KPI’s were relevant in practice. The feedback helped to identify the areas of improvement in the tool and receive constructive feedback on the benefits of the tool. With respect to the applicability of the tool in a broader perspective, some optimization for a cleaner dashboard output with less detailed input value entry was deemed necessary.

Nevertheless, the primary purpose of knowledge transfer from the tool kit stood accomplished due to the widespread collection and validation of the KPI's. Even though some of this information were already implemented or in the knowledge of the companies and their strategies, partners always highlighted new information from the tool kit, making it a valuable resource for the promotion of the combined transport sector.

6.6.5 Application in BSR and Future Scope

The holistic research and data collection gave the opportunity of creating a basic and self-explaining sustainability practices evaluation tool kit using the KPI's for the combined transport sector of the Baltic Sea Region. By using this tool kit, different players in the CT chains can easily perform a self-evaluation by becoming aware of the diverse aspects of sustainability and as well learn about the best practice examples from the industry to initiate the first steps towards implementation of solutions.

The wide-ranging information received from the tool kit can be used for marketing or for further strategic planning by the users. Therefore, the value of the tool kit is notable with multiple benefits to the users starting from the knowledge transfer, the motivation to focus more on all pillars of sustainability, set internal targets or even release simple sustainability reports themselves based on the outputs of this tool kit.

In order to make the tool kit available to any player of the Baltic Sea Region in future, SGKV as a neutral and not for profit organisation has developed a new page on its open resource website https://www.intermodal-info.com/en/sustainability-and-combined-transport/, that offers an introduction to the tool kit and contacts for using the tool kit. An insight into the webpage is documented in Figure 80 below.

Figure 77: Sustainability Practices Review Tool Kit Webpage

LITERATURE-GENERAL

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Note: The literature for spatial analysis and sustainability practices review toolkit listed below are not directly referenced in this report since they were used in the process of creating these tools. Hence, they could not be linked directly with specific text sections explaining these tools and its applications. Though most of these resources were open source, they are listed here to provide an opportunity for the readers to understand the background and use them for further reading.

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Administrative boundaries data from EuroGeographics

Base map data by OpenStreetMap contributors

Combined Transport Terminals from SGKV Intermodal Map

Isochrones created by openrouteservice.org by HeiGIT

Populated places (Cities) data from Natural Earth Data

Real growth rate of regional gross value added (GVA) data from Eurostat

Road and Railway transport network data licensed from EuroGeographics

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